

**SUPPORTING REMOTE SYNCHRONOUS COMMUNICATION  
BETWEEN PARENTS AND YOUNG CHILDREN**

A Thesis  
Presented to  
The Academic Faculty

by

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In Partial Fulfillment  
of the Requirements for the Degree  
Doctor of Philosophy in Human-Centered Computing in the  
School of Interactive Computing

Georgia Institute of Technology  
May 2012

# SUPPORTING REMOTE SYNCHRONOUS COMMUNICATION BETWEEN PARENTS AND YOUNG CHILDREN

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*I dedicate this thesis to all of my families. May we never feel separated.*

## ACKNOWLEDGEMENTS

First of all, this work would be impossible without the thoughtful guidance of my advisor and my committee members: Gregory Abowd, Amy Bruckman, Ellen Yi-Luen Do, Panos Markopoulos, and Elizabeth Mynatt.

Secondly, this work would not have happened without the wonderful participants who have volunteering their time and often disregarded their privacy in order to help me answer my questions about separated families.

Third, funding from a number of organization has supported me and my work throughout the Ph.D. process:

- AT&T Graduate Fellowship supported me in years 2, 3, and 4 of my Ph.D.
- IBM Graduate Fellowship supported me in years 5 and 6 of my Ph.D.
- Nokia University Award funded many of the equipment and deployment costs for the ShareTable
- Kynamatrix Grant helped fund conference travel so I could talk about this work
- Georgia Tech supported me with a GTRIC award and an out-of-state tuition waiver in years 5 and 6
- GVU supported my conference travel in years 1, 2, 3, and 4 so I could begin formulating my research

Finally, none of this work was done alone. A number of fellow students collaborated with me throughout this process and volunteered their time to aid with the logistics of carrying out these investigations (in alphabetical order):

- Berke Atasoy
- Fatima Boujarwah
- Yee Chieh “Denise” Chew
- Stephen Cuzzort



- Brian Di Rito
- Yi Han
- Jee Yeon Hwang
- Kurt Luther
- Yevgeniy Medynskiy
- Sanika Mokashi
- Hendrik Muller
- David Quigley
- Shashank Raval
- Duane Rollins
- Hina Shah
- Jasjit Singh
- Caleb Southern
- Jay Summet
- Anthony Tan

Thanks for all your help!

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## SUMMARY

Parents and children increasingly spend time living apart due to marital separation and work travel. I investigated parent–child separation in both of these contexts to find that current technologies frequently do not meet the needs of families. The telephone is easy-to-use and ubiquitous but does not provide an engaging way of interacting with children. Videochat is more emotionally expressive and has a greater potential for engagement but is difficult to set up and cannot be used by a child without the help of an adult. Both telephone and videochat fail to meet the needs of remote parenting because they focus on conversation rather than care and play activities which are the mechanism by which parents and children build closeness. I also saw that in both types of separation the motivation to connect at times conflicted with desire to reduce disruption of the remote household.

To address some of these issues, I designed a system called the ShareTable, which provides easy-to-initiate videochat with a shared tabletop activity space. After an initial lab-based evaluation confirmed the promise of this approach, I deployed the ShareTable to four households (two divorced families). I collected data about the families’ remote interactions before and during the deployment. Remote communication more than doubled for each of these families while using the ShareTable and I saw a marked increase in the number of communication sessions initiated by the child. The ShareTable provided benefits over previous communication systems and supported activities that are impossible with other currently-available technologies. One of the biggest successes of the system was in providing an overlapped video space that families appropriated to communicate metaphorical touch and a sense of closeness. However, the ShareTable also introduced a new source of conflict for parents and challenged the families as they tried to develop practices of using the system that would be acceptable to all involved. The families’ approach to these challenges as well as explicit feedback about the system informs future directions for synchronous communication systems for separated families.

## CHAPTER I

### INTRODUCTION

Residential parenting is becoming a single-person occupation for a large proportion of American families. In the past, a household with children may have included both parents, various grandparents, and even aunts and uncles; in 2008, 26% of children live with just their mother or just their father [33]. In a quarter of families where the parent lives apart from his or her children, she or he actually resides in a different city [55]. Even in families with both parents in the household, the time that parents and children spend together is decreasing as parents spend more time away at work and with increasing travel for business [152]. These trends may have long-term impact for the current generation, as children strongly benefit from having regular contact in diverse contexts with as many adults as possible [94]. Face-to-face contact provides many advantages but may not always be possible. Increasingly, families are turning to communication technologies for achieving contact remotely to supplement in-person time [55].

For most families who are separated, the telephone is the primary method of maintaining remote contact, despite the difficulties of using this medium with children [12]. Increasingly, families are seeking out alternative forms of synchronous and asynchronous communication to supplement contact. Successful attempts at leveraging tools like videochat and instant messaging for remote parenting have drawn attention from the news media. The New York Times had several recent articles about videoconferencing with children in work-separated families [35] and with extended family [75]. The Washington Post and USA Today have both featured articles on virtual visitation—using communication technologies to augment face-to-face time—between parents and children in divorced families [27, 153]. There are efforts to incorporate virtual visitation into family law in almost every state, with five states already having added provisions for virtual visitation to custody case law [41]. Remote parenting is a relevant issue to families, law makers, and technology designers and is thus

ripe for investigation from a Human-Centered Computing perspective.

### ***1.1 Research Questions***

Despite the attention that remote parenting is receiving in the media, there have been few research investigations explicitly exploring how parents and children may leverage technology to maintain contact. The goal of this work is to rigorously investigate remote parenting practices with current and novel communication technologies to provide informed implications for design and guide future work in this area. In service of this goal, there are four research questions that this thesis will address.

**RQ1** What are the current communication practices and challenges for parents and children in families separated by divorce?

**RQ2** What are the current communication practices and challenges for parents and children in families separated by work?

**RQ3** How does a system that provides easy-to-initiate videoconferencing and a shared tabletop space (ShareTable) support or hinder remote parent-child communication?

**RQ4** How does the ShareTable compare to other communication technologies used by divorced families?

The remainder of this dissertation will describe the investigations I have conducted to address these four questions, as well as interpret my findings in the context of designing new technologies in this domain.

### ***1.2 Contributions***

In this section, I summarize the contributions of this thesis. In addressing RQ1 and RQ2 by conducting in-depth interviews with distributed families, I have contributed to the overall understanding of the role of technology in remote parenting practices currently in use by families and of the needs and challenges of parents and children using these communication technologies. Focusing on both divorced and work-separated families, has allowed me to compare and contrast the needs of these families to gain a richer understanding of

each unique context. In both investigations, I provide concrete implications for design and directions for future systems.

In order to investigate RQ3 and RQ4, I created a novel prototype communication technology called the ShareTable. The ShareTable uses the physical metaphor of opening and closing a cabinet to provide easy-to-initiate videochat. In addition to the face-to-face video view, it provides a full-duplex camera-projector shared tabletop system to support shared activities. Implementation details of this prototype and all of the required code have been documented and made freely available to other investigators. A lab investigation and a field deployment of this technology have served as a proof-of-concept for this system and have contributed to the understanding of how families appropriate new communication technologies by providing specific evidence of family practices through video logging and weekly interviews.

In order to allow for a standardized comparison of the ShareTable system to other communication technologies used by separated families, I developed and validated a questionnaire instrument for evaluating communication technologies: the Affective Benefits and Costs of Communication Technologies (ABCCT) questionnaire. I have piloted and performed an initial validation of this instrument with a sample of children (over the age of seven) and adults. I propose that this instrument provides a standardized means to compare communication technologies and a useful supplement to the rich qualitative methods typically used for such investigations.

Thus, the contributions of this dissertation are as follows:

1. In-depth interviews, providing a better understanding of the practices and challenges of separated families in two contexts: separation due to divorce and separation due to work.
2. The initial measures of reliability and validity of a questionnaire instrument for evaluating communication technologies with adults and children (ABCCT).
3. The design and implementation ShareTable system, which provides easy-to-initiate videoconferencing and a shared tabletop space for remote communication.

4. A field evaluation of the ShareTable system, providing a better understanding of how such technologies are used and adopted by parents and children in separated families.

This is not an exhaustive list of contributions and outcomes but highlights of the specific deliverables that can be considered in evaluating this dissertation work. Appendix D provides a summary chart enumerating the investigations that contributed to each item on the above list, as well as participants and data collected in each phase of the work.

### ***1.3 Overview of Thesis***

I begin this dissertation by motivating why it is important to design communication technologies to support remote parent-child interaction, as well as discussing my personal motivations in this space (Chapter 2). In Chapter 3, I provide an overview of previous investigations in the area of understanding and supporting family communication, highlighting how my contributions fit into the larger picture of the ongoing investigations in this domain. In Chapters 4 and 5, I describe my investigations aimed at understanding the current practices and challenges faced by families separated by divorce and by work travel. Chapter 6 describes my work designing and validating a questionnaire for adults and children, used to evaluate the affective benefits and costs of communication systems. Chapter 7 provides a discussion of my design process in creating the ShareTable system and outlines the initial lab-based evaluation that provides a proof-of-concept for the system. In Chapter 8, I describe the field evaluation of the ShareTable system with four households in the Atlanta area. Finally, I discuss the overarching assumptions and frameworks that define my dissertation and outline new opportunities and challenges in this domain.

## CHAPTER II

### MOTIVATION

Previous research in supporting social connectedness between remote participants focuses mainly on communication between adult parties. However, parent–child separation is a relatively unexplored area with a great potential for impact through technological intervention. In this section, I provide statistics about the widespread nature of remote parenting, explain some potential consequences of parent–child separation, and make the case that communication technology may be a moderating influence. Finally, I discuss my personal motivations as a researcher, my background, my values, and the influences of these factors on my stance as an observer.

#### *2.1 Prevalence of Parent–Child Separation*

Many families may face periods of time when one parent does not live in the same household as the child, though the exact number may be difficult to establish. Reasons for permanently living apart may include the divorce or separation of the parents, resulting from the fact that 40–50% of first marriages in the United States end in divorce [4]. The U.S. Census provided a 2008 report on the living arrangements of children under 18, highlighting that 30% of the children surveyed did not live in the same household with both of their parents [33]. An earlier report established that 25% of those children live not just in a different household, but in a different city from their parent [55]. Additionally, a child may spend periods of a month or more living away from the primary parent while still being considered as living in the same household for census purposes. The U.S. Census explored this possibility in a separate report on children under 18 living apart from the designated parent, finding that 14.7% of such families have ever lived apart for longer than a month [34]. In divorced or separated families, that number is as high as 28.5%. Reasons for temporary separation include visitation travel, travel for work (e.g., military deployment), incarceration, hospitalization, and more. Additionally, on average the amount of time that parents

and children spend playing together has been declining since 1981 [152]. The U.S. Census report on selected indicators of a child’s well being found that in 2006 only 51% of children over 6 were talked to just for fun or played with by their parent for 5 minutes or more 3 or more times per day [32]. Thus, a significant proportion of children in the United States may be receiving significantly different parenting than in previous generations.

## ***2.2 Consequences and Moderators of Separation***

Separation carries significant negative consequences for both the child and the parents. Even temporary separation carries negative effects. Applewhite & Mays [9] highlight that children in families separated by the military deployment of either parent often face a greater degree of psychological and behavioral problems than intact families. Families separated by the incarceration of one of the parents face an even more serious battery of disadvantages [123]. Ginsburg emphasizes the importance of regular and frequent play time between parents and children in developing the child’s cognitive and socio-emotional competencies, but also points out that separation is making it increasingly difficult to meet this goal [68].

Most of the previous research on parent–child separation focuses on the effects of marital disillusion on family function. Amato presents a synthesis of the literature on parent–child relationships in divorced families [4]. A consistent finding across divorce literature is that both the parents and children in divorced families tend to score lower on multiple measures of well-being and adjustment. Synthesizing previous work on the possible mediators (characteristics that are likely to lead to a worse outcome) and moderators (characteristics that are likely to lead to a better outcome) of the negative consequences of divorce on parents and children, Amato found that for the parents, difficulties associated with solo parenting (for the primary parent), loss of contact with children (for the secondary parent), continuing discord with the former spouse, and declines in emotional support account for much of the gap in well-being between divorced and married adults. Moderators for parents include presence of emotional support (especially, when it doesn’t come with “any strings attached”). For the child, lack of cooperation or hostility between parents and the lack of authoritative parenting were among the mediators. Moderators for children included social

support, use of active coping skills, and joint custody.

However, Amato also found that while divorce usually has negative consequences, these can be moderated by the distributed parent staying instrumentally involved in the child's life [3]. Smyth emphasizes that the quality of contact may be as important to explore as the quantity [163]. "Quality contact" may be difficult to unpack, but developmental psychologists have used the term "authoritative parenting" to describe the combination of monitoring and support that is likely to lead to positive behavioral and academic outcomes for children [163]. Gray & Steinberg isolated and examined the behaviors that characterize this construct to find that the amount of communication and the act of showing interest in the child's life were the most influential constituent behaviors involved in authoritative parenting [70]. Additionally, frequency and variety of contact are also important to maintaining relationship quality. Kelly & Lamb advise that parenting arrangements should provide "opportunities to interact with both parents every day or every other day in a variety of functional contexts" [94]. Unfortunately, these prerequisites for quality contact may be difficult to achieve. Seltzer & Bianchi showed that the quality and quantity of contact with the distributed parent decreased dramatically after the first year of separation [158]. One of the reasons they cited for this loss of contact was geographic separation. Achieving interaction in a variety of functional contexts is also difficult for the non-residential parent. Furstenberg & Nord studied patterns of parenting after separation to show that the distributed parent was likely to be involved socially in the child's life, but rarely set rules or assisted with care activities such as helping with homework [63]. In other words, while it is theoretically possible to reduce the negative consequences of separation by maintaining meaningful parent-child contact remotely, in practice this is very difficult to achieve under current constraints.

### ***2.3 Role of Technology***

Though I could find no studies investigating the effect of available communication technologies on maintaining contact between parents and children, the Pew report on the American "networked family" showed that such technologies do have the potential to raise the quality



of communication with friends and family [95]. Fifty-three percent of respondents indicated that mobile phones and the Internet have increased their quality of communication with friends and distributed family (44% said that it remained the same). The report also indicated that increases in time spent using social media comes at the expense of time spent watching television, not at the expense of time spent socializing in-person. Most families already have the infrastructure to use communication technologies such as videochat and many seem to be excited by the opportunities provided by these media.

A more recent investigation specifically explored video calling and videochat use by American families, finding that 23% of adult Internet users have tried video calling online or via their cell phones [146]. While only 4% reported having done so “yesterday,” the number has doubled (from 2%) between 2009 and 2010. So, while few users currently use videoconferencing regularly, these technologies seem to be showing great promise in supporting connectedness.

“Non-traditional” family arrangements such as single-parent households tend to be young and tech-savvy [95]. Non-residential parents often turn to technology to supplement in-person communication. Some parents maintain websites and forums dedicated to sharing ideas about using technology to stay in touch, such as [distanceparent.org](http://distanceparent.org) and [internetvisitation.org](http://internetvisitation.org). In particular, the combination of telephone, videoconferencing, and instant messaging to supplement in-person visits is known as virtual visitation [55]. As of 2009, five states have passed laws allowing virtual visitation to be incorporated into custody decisions [11]. Several family law periodicals have featured virtual visitation, stating that “technology may be able to help maintain a relationship that would otherwise cease” [159]. Despite being already becoming incorporated into state law, there has been relatively little academic or industry research into how families use technologies like videochat.

## ***2.4 Personal Background, Motivation, and Stance***

Traditionally, ethnographic studies include a brief biography of the investigator, in order to bring to light possible biases and assumptions that may have influenced the work. Though I have not conducted an ethnography in this thesis, most of my data is qualitative and is

likely to be influenced by my stance as an observer. Thus, I also provide a brief biography, underscoring my relationship with the topic of this thesis. Remote contact with children has special personal meaning in my life. I was born in 1983 in Moscow, Russia. I spent most of my childhood as an only child living in a household of 6 adults, including my parents, grandparents, and my great-grandmother. When I was 7, my father began the process of preparing to move us out of the politically and economically unstable Russia. For the next 4 years, we lived apart as he worked in a different city in Russia, then in Hungary, and finally in the United States. There was very little contact between my father and me while he was out of the country, perhaps one of the motivating factors in my choosing this topic of research. When I was 11, my father was able to bring my mother and me to the United States to join him permanently. I developed a close relationship with my brother who was born after the immigration. In order to be able to stay an active part of my brother's childhood, I chose to attend university close to home and frequently spent time with him. However, I moved away to attend graduate school at Georgia Tech when he was 9 years old. Through this experience, I was able to appreciate the difficulties of remote contact with children from the perspective of an adult. The challenges of maintaining closeness with my brother led me to seek advice in online long-distance parenting forums which drew my attention to the issues of separated families and motivated this thesis.

Additionally, my values and motivations as an investigator influence my approach to addressing parent-child separation. In a 2011 IDC paper, I and other investigators identified five categories of values expressed in the domain of interactive design for children through a meta-analysis of all previously-published work at this venue [193]. Here, I use a similar categorization to foreground the assumptions and biases I bring to the investigations that follow. I address (1) values about the kinds of research contributions I find important, (2) values about the kinds of behaviors and qualities I aspire to support in children and adults, (3) values about for whom I design and the role of the user in that process, (4) values related to the theories and models that I use and produce, and (5) my values regarding priorities in technical design.

**Contributions I Seek to Make.** I contribute several studies and a system, because I see

both types of contributions as being valuable to HCI. Additionally, I find it important that as a field we continue examining our values and iterating on the methods used, which is why a significant portion of this thesis is devoted to the development of a novel instrument for evaluating communication technologies. Lastly, I find it important to design and evaluate in an authentic context, which is what motivated me to begin the significant undertaking of creating a robust prototype of my thesis system rather than constraining my work to lab investigations.

**Qualities I Aspire to Support.** The main quality that I aspire to support is family connectedness. This stems from the assumption (supported by previous work) that children benefit from contact with important adults in their life. In particular, I value the type of social interaction that is frequently unstructured and user-driven (rather than consumption of content created by others). I seek to support both children and adults in discovering playfulness, creativity, and self-expression through time spent in free play. There are a number of assumptions here that I discuss in more detail in the following chapters. I understand that not all children may benefit from increased contact with all of the adults in their lives and not all families may be able to create engaging interactions without additional structure, however I choose to take an optimistic approach in my designs. Lastly, I seek to support the child’s autonomy in driving the communication with important adults in his/her life. While children may not always be able to make the best decisions about communication, I think it is important to provide them with the chance to try and potentially learn from the experience.

**Users and Users’ Role.** My work requires balancing the interests of multiple stakeholders. In order to do so, I chose to include all three groups—children, residential parents, and non-residential parents—as informants in the design and evaluation process. I particularly find it important to reflect children’s voices in my work, because I see children as active agents in their own parenting. When the interests of the residential and non-residential parents are in conflict, I choose to resolve the impasse by focusing

on the interests of the child.

**Role of Theory.** Though my work is not explicitly driven by theory, it is informed by a number of developmental and interaction theories. For example, I am influenced by basic developmental theory such as the Piagetian stages of development. In particular, I find it important to keep in mind that perspective-taking is a difficult skill for many young children and one that is required in successfully using communication technology such as videochat. In terms of interaction theories, I am influenced by Paul Dourish’s articulation of “embodied computing” as an approach that leverages existing expertise with tangible objects and social situations [48]. This theory helped inform the design of the ShareTable system, as described in a later chapter. Additionally, I use theory as a lens to help organize my observations. In particular, Activity Theory appears relevant as an organizational structure for understanding remote parenting. I return to this idea in more detail in the discussion chapter.

**Design Priorities.** In my design, I am drawn to technologies that bridge the physical and the digital. I seek to explore novel technologies that achieve these goals but only as motivated by the context in question, rather than as a way of advancing the technology itself. As a designer, I value the ideas of engagement, naturalness, and enjoyment and strive for these in the systems that I build. Additionally, I operationalize these qualities in the longterm rather than as something that can be measured after a brief controlled engagement. As a designer, this leads me to focus on designing flexible media for communication rather than creating specific content that would need to be updated to remain enjoyable and engaging.

These five classes of values are evident in the work that I present in the remainder of this thesis. They shape my focus as an observer, my approach as a designer, and my stance as an evaluator—my findings must be considered in the context of these biases and limitations despite my ongoing efforts at external validation.

## *2.5 Conclusion*

Parents and children spend time living apart in a large proportion of American families. Such separation can carry long-term consequences for the child. New communication technologies can help maintain this relationship and have received positive attention from many separated families. My assumption as a researcher is that with appropriate support, novel communication technologies can change the nature of remote parent–child contact for the better. Despite interest in such systems from separated families and the potential of such systems for affecting positive change, there have been few investigations of technology use between distributed parents and children. In the next chapter, I review relevant previous investigations into communication technology and parent–child separation. The remainder of this thesis presents and discusses my investigations in this domain.

## CHAPTER III

### RELATED WORK

In this chapter, I discuss relevant related work on current technology use and designing communication technologies for family connectedness. I provide a brief overview of the remote synchronous communication work outside of the home to highlight how my work builds upon these previous investigations. Finally, I discuss related work and background on designing for the parent-child relationship to highlight some unique characteristics of this context.

#### *3.1 Current Communication Technology Use in the Home*

Families' relationship with communication technology in the home is continually evolving and changing. In Chapters 4 and 5 of this thesis, I present formative investigations of separated families' strategies around communication technologies through in-depth interviews. However, those interviews were collected between 2006 (earliest interviews presented in Chapter 4) and 2010 (earliest interviews presented in Chapter 5) and only discuss the experiences of 24 different families. In this section, I present several recent large-scale quantitative investigations into the use of communication technology in the home.

A large scale quantitative investigation of American families' use of communication technology was conducted by Pew Internet & American Life Project in 2008. The vast majority of American households with children have access to a cell phone and a computer in the home (95% and 93% respectively) [95]. Most computers are networked, with 94% having some opportunity for Internet access and 66% having a home broadband connection [95]. The phone is the most common communication technology in use between parents and children—75% of parents use landline phones and 73% of parents use cell phones to connect with their children [95]. 35% of parents reported connecting with their children via a landline daily and 54% report using the cell phone to contact children daily. Email and text messages are also a popular form of communication, with 25% and 21% of parents

reporting having used each of these with their children [95]. Pew more recently followed up with an investigation of videochat use (which was conspicuously missing from the 2008 report). This 2010 investigation found that out of the 74% of Americans who use the Internet, 23% have tried videochat and 4% report having “used it yesterday” [146].

Both of the investigations described above focused on adult use of communication technologies, but several investigations have looked at children’s use as well. The majority of these investigations focus on technology use by teenagers (ages 12 – 17). For example, a 2010 investigation found that 75% of teenagers own cell phones and 69% own computers [109]. Investigations of teenagers’ use of mobile phones focus on the proliferation of texting, social use among teenagers, and parents’ approach to setting rules around cell phone use (e.g., [108]). However, there are considerably fewer investigations of technology use by children younger than 12. A 2010 investigation asked about the age at which children currently get a cell phone, finding that only 3% own a cellphone before the age of 10 [107], but 20% have one by age 11. In a slightly different approach, a 2011 investigation asked parents at what age they were planning to provide a cell phone for their child [168]. According to this investigation, 10.6% of parents are planning to get a cell phone for their child by the age of 10 and 42.7% by age 11. In general, it seems that children are getting cell phones at a younger age, though there is still a great deal of controversy about the appropriate time for this milestone to occur [168] and the longterm consequences of mobile connectivity at a younger age [8].

In the next section, I focus on how HCI has approached investigating and designing communication systems for families.

### ***3.2 Designing to Support Family Connectedness***

In this section, I discuss previous work on supporting family communication and connectedness in the loose context of time-space groupware framework [87]. Figure 1 provides a tabular representation of this organization. Notice, that rather than focusing on “remote” versus “local” interaction (as in the time-space framework), I rather divide the work into

that focusing on designing to support communication among family members that live together versus those focusing on designing to support communication among family members that live apart, which is a more clear distinction for this particular context. Lastly, note that this review covers work where the aim is to design technology to support family connectedness. While there are many investigations in the social science domain that may be relevant, I have included only those specifically focusing on informing the design of new technologies.

		Connecting Families Living Together	Connecting Families Living Apart
Synchronous	Formative Study	Domestic Communication (Crabtree, Hemmings, Rodden 2003) Working Parents (Sellen, Hyams, Eardley 2004) Console Gaming (Voida et al. 2010) Pick-Up Patterns (Davidoff et al 2011)	Conversational Context (Evjemo et al 2004) Mediated Intimacy (Dalsgaard et al 2006) Mobile Video (O'Hara, Black, Lipson 2006) WoW (Nardi, Harris 2006) Homework (Fraser, Rodden, O'Malley 2007) Extended Fam. (Tee, Brush, Inkpen 2009) <b>Divorced Fam. (Yarosh, Chew, Abowd 2009)</b> Grandparents (Vetere et al 2009) Telephone (Ballagas et. al 2009) Videochat (Ames et al 2010) Videochat (Judge, Neustaedter 2010) Videochat (Kirk, Sellen, Cao 2010) Videochat (Rainie, Zickuhr 2010) Across Timezones (Cao et al 2010) <b>Work-Separated Fam. (Yarosh, Abowd 2011)</b> Immigrant Fam. (Wong-Villacres, Bardzell 2011)
	Design Only/Lab Prototype	Squeeze (Petersen 2007)	SmallConnection (Ogawa, Ando, Onodera 2005) PlayPals (Bonanni et al 2006) Age Invaders (Khoo et al. 2006) Huggy Pajama (Teh et al 2008) <b>ShareTable (Yarosh et al 2009)</b> Video Playdate (Yarosh, Inkpen, Brush 2010) Doll House (Freed et al 2010) Video Play (Follmer et al 2010) Family Story Pay (Raffle et al 2010) Communiclay (Raffle et al 2011) RopePlus (Spingarn-Koff, Cheng 2011) PiXIO (Inpen, Junuzovic 2012)
	Field Evaluation		Family Window (Judge et al. 2010) Wayve (Lindley, Harper, Sellen 2010) StoryVisit (Raffle et al 2011) <b>ShareTable (See chapter 8)</b>



Asynchronous	Formative Study	Domestic Communication (Crabtree, Hemmings, Rodden 2003) Calendars (Crabtree et al 2003) List Making (Taylor, Swan 2004) Working Parents (Sellen, Hyams, Eardley 2004) Pick-Up Patterns (Davidoff et al 2011)	Teenagers Text (Grinter, Palen, Eldridge 2006) Mediated Intimacy (Dalsgaard et al 2006) Homework (Fraser, Rodden, O'Malley 2007) Friendships after Moving (Shklovski et al 2008) <b>Divorced Fam. (Yarosh, Chew, Abowd 2009)</b> Grandparents (Vetere et al 2009) Extended Families (Tee, Brush, Inkpen 2009) Divorced Families (Odom, Zimmerman 2010) Email w/ Grandparents (Lindley 2010) Across Timezones (Cao et al 2010) <b>Work-Separated Fam. (Yarosh, Abowd 2011)</b> Immigrant Fam. (Wong-Villacres, Bardzell 2011)
	Design Only/Lab Prototype	Cherish Frames (Kim, Zimmerman 2006) LINC (Neustaedter, Brush 2006) Memento (West, Quigley, Kay 2007)	Feather, Scent, Shaker (Strong, Gaver 1996) Peek-A-Drawer (Siio 2002) Virtually Together (Tollmar et al 2000) Casablanca (Hindus et al 2001) Communication Appliances (Kim et al. 2004) Affection Devices (Truong et al 2004) Casy (Zuckerman, Maes 2004) Virtual Box (Davis et al 2005) Tangible Messages (Feltham et al 2007) <b>eMutts (Yarosh et al 2009)</b> Craftables (Freed et al. 2011) With Toddlers (Raffle et al 2011) Grandparents (Moffatt, David, Baecker 2012)
	Field Evaluation	TxtBoard (O'Hara et al 2005) HomeNote (Sellen et al 2006) Busy Families (Khan, Markopoulos 2009) BubbleBoard (Lindley et al. 2009)	ASTRA (Markopoulos et al. 2004) CareNet (Consolvo, Roessler, Shelton 2004) Digital Family Portraits (Rowan, Mynatt 2005) Intimacy Bits (Kaye et al. 2005) Shared Calendars (Plaisant et al 2006) The Cube (Howard et al 2006) Hermes@Home (Saslis-Lagoudakis 2006) Sharing Motion (Bentley, Metcalf 2007) Whereabouts Clock (Brown et al 2007) SPARCS (Brush, Inpen, Tee 2008) eKiss (Dalsgaard, Skov, Thomassen 2007) Globetoddler (Modlitba 2008) Collage (Vetere et al 2009) Magic Sock Drawer (Gooch 2011) Video Kids (Inkpen et al 2012)

**Figure 1:** The related work on supporting family connectedness can be organized using a loose adaptation of the time-space groupware framework [87]. Papers may appear in more than one section where appropriate. My contributions through the work presented in this thesis are highlighted in boldface.

### 3.2.1 Synchronous Technologies for Family Members that Live Together

When families are together in the same place, they often use games, toys, and media as a way of supporting and enriching their interaction. Examples can include getting together

for board game night or discussing related situations while watching a TV show. Formal investigations of artifacts that support in-person interaction have focused on the role of media, such as the social uses of television or gaming [114, 181] and sharing photos in-person [40]. Additionally, several formative investigations have recognized that synchronous communication plays a big role in supporting family coordination, such as coordinating the pick-up patterns of children [44] and work schedules [157]. However, other than some early conceptual designs for “communication appliances” [101, 138], designing systems for supporting synchronous interaction between family members who live together has up till now been the domain of game and entertainment designers rather than the HCI or CSCW research communities.

### **3.2.2 Asynchronous Technologies for Family Members that Live Together**

Several projects have done an excellent job at addressing asynchronous communication within a single household. Crabtree et al. studied how families use calendars to coordinate everyday activities [39]. This work informed the creation of shared family calendar systems for connecting family members both in the same household [127] and in different households [140]. Taylor and Swan explored how shared lists in the home serve as a form of asynchronous communication [170]. Informed by both of these projects, HomeNote [156] created a home hub for messages that could be broadcast and read by family members. They discovered that the messages served many functions in the home, including social, expressive, and coordination. Similarly, TxtBoard [134] explored the idea of messaging from an individual to the entire household and BubbleBoards [111] explored audio messaging. These projects addressed asynchronous interaction on a relatively short timescale, however there has also been interest in how families record and preserve memories that can be discovered years or even decades later. One area of long-term asynchronous interaction that has been explored is that of sharing photographs [40] and videos [1]. Another example is the Memento system [184], which supports users in creating a hybrid physical-digital scrapbook. Kim & Zimmerman explored in more detail how this sort of sharing could represent a form of communication within a family by allowing the users to create narratives for the

home through digital photography [100]. It is interesting to note that there is a roughly equal distribution of projects in this area between those that provide formative insights, those that suggest early designs, and those that test design ideas through field deployments (see Figure 1).

### **3.2.3 Asynchronous Technologies for Family Members that Live Apart**

The majority of research in supporting family communication has focused on asynchronous remote communication. There is a great deal of formative work focusing on use of specific asynchronous media ([71, 110, 171], specific separation contexts [160, 178, 30, 187, 188, 186], and for specific goals [58, 42]. This work has served to inform a number of designs, early prototypes, and robust prototypes tested in field deployments.

One pervasive theme of asynchronous remote family technology is that of maintaining awareness and peace of mind. The Digital Family Portrait [124] allows an adult child to receive information about their elderly parent’s routine through an ambient display on a picture frame. Similarly, the CareNet Display [36] uses an ambient display to assist with aging-in-place by providing health information to the elder’s local social network. Location sharing has become a common trend more recently, for example the Whereabout Clock [25] and phone-based location sharing [18] both provide low-granularity location information to family members. Shared Family Calendars [140] allow awareness of each other’s activities without extra work to enter and share information, by digitizing already maintained calendars. All of these projects were focused on supporting awareness of family members. There has been considerably less work in creating similar awareness mechanisms that leverage existing activities of children.

Another major theme in asynchronous family communication systems is allowing users to leave messages for each other as sketches and notes [69, 154], photographs [178, 43, 26, 117], audio [53] and even video [194, 84]. As an example, the ASTRA awareness system [117] combined a camera and PDA to allow family members to exchange messages that could then be viewed at leisure in the home. This system focused on the theme of maintaining closeness and awareness without creating new obligations or violating the privacy of either

party. Another example, the SPARCS system [26] employed sharing suggestions in order to increase photo sharing between family members. Sharing images is also a particularly popular feature for connecting adults and children. One system, Peek-a-Drawer [162], was designed to support the interaction between a grandparent and a grandchild by simplifying the sharing of digital images of physical artifacts. When the child or the grandparent puts an object into the upper drawer of a chest, an image of that object would appear on the screen of the lower drawer of the sister chest. Family Collage [178] and eKiss [43] include a public in-home display for showing images shared through mobile phones to seed conversations and encourage a sense of social connectedness.

Other investigators have explored playful asynchronous communication in the home context. The Virtual Box [45] adds a twist to sharing images—the process is a game of hide-and-seek where parents and grandparents “hide” virtual boxes of images for their children to find later. Globetoddler [120] combines image sharing and asynchronous Flash games with a soft toy interface to allow business travelers to interact with their children. Other systems have explored ambient awareness and communication devices that are abstract and open to individual appropriation (e.g., [166, 60, 81, 92]).

Overall, there has been a great deal of exploration of asynchronous communication systems in the HCI domain. A good number of these investigations have matured to include field deployments of systems in the home. While asynchronous systems are compelling because they create fewer obligations and bypass issues of time-zone differences, they often rely on the idea that the messages that are sent could later be discussed in a synchronous fashion, whether in-person or over an electronic medium. I focus on the less-explored area of synchronous remote communication in this thesis.

### **3.2.4 Synchronous Technologies for Family Members that Live Apart**

There have been a number of formative investigations exploring synchronous communication technology use among family members that live apart. Early investigations have shown that the telephone is not an effective way of supporting family communication, because it does not support a shared conversational context [52] and is particularly difficult for

young children [12]. More recently, videochat has presented a compelling alternative to audio-only communication, gaining the attention of the HCI community with four separate in-depth investigations released in the same year [6, 88, 102, 146]. All four of these studies point to enthusiastic adoption of this tool in the home and a number of potential benefits it provides in supporting communications. However, investigations of communication in specific contexts show that this tool is frequently not available to families separated by divorce, work, or immigration [188, 187, 186]. Thus, a number of novel technologies have been developed to augment the opportunities provided by telephone and videochat.

Several of these investigations focus on creating a way to support remote synchronous tangible interaction. For example, some of the projects use networked actuators to support sculpting together [141], playing simple rope games [164], and playing with networked poseable dolls [20]. Perhaps because the technology involved is relatively new and non-robust, none of these systems have been tested outside of the lab.

A number of these investigations focus on providing additional contexts to videochat. For example, Family Story Play [142] and StoryVisit [145] combine videochat with reading a book together. PiXIO [85], ShareTable [189], and Video Playdate [191] encourage free play with physical toys while talking over videochat. Most of these novel systems were tested only in the lab. Only most recently, have HCI researchers taken novel synchronous remote communication systems outside of the lab and into field deployments. The Family Window [90] provides always-on, 1 fps, video-only media space between two or more households. Wayve [112] provides a small information appliance with a number of connection features including videochat and sending written or drawn messages. Both of these systems have focused on making videochat easier to initiate and use. One of the biggest contributions of this thesis is a field deployment of the ShareTable system (see Chapter 8) which expands considerably on the previous work in this domain and helps address the gap in the area of remote synchronous family interaction.

### *3.3 Synchronous Remote Communication Systems Outside the Home*

My review would be remiss without at least a brief overview of remote synchronous communication systems research outside of the home context. Videoconferencing and video media spaces have had a long history of exploration in the work place [19], allowing me to draw on relevant findings from this domain. Several CMC theories point to the fact that synchronous video may be an appropriate medium for casual communication [183]. Media Richness Theory emphasizes that ambiguous and uncertain tasks require more immediate feedback, more cues for communication, and more emotional awareness. Social Presence Theory suggests that video affords social awareness of the partner’s state in a way that is more similar to in-person interaction than other media, and thus may be better at supporting tasks that are usually carried out in-person. However, there is significantly less theoretical grounding to suggest what kind of synchronous video may be good for supporting social and playful communication.

There were a number of early projects in the workplace exploring the idea of combining videoconferencing with a shared space for writing, drawing, and collaborating over physical artifacts (e.g., [86, 169]). However, empirical work in the space revealed that videos of the collaborative task space and videos of the larger context of the remote room may often be more useful to remote participants than the face-to-face video view [66]. As more of the activity of the workplace moved into the digital space, the focus of office groupware systems shifted from videoconferencing with physical artifacts to asynchronous shared workspaces (e.g., [49]). There are still novel synchronous communication technologies being developed for the workplace, but the focus has shifted considerably from synchronous collaboration to team-building and social proxies (e.g., [177, 51]). While the workplace did not provide a compelling context for system that supports synchronous collaboration over physical artifacts, the home may in fact do so. A number of investigations have found clear advantages to pairing videoconferencing with a shared physical work/play space for supporting remote interaction with children [85, 191, 189]. One of the contributions of my thesis is providing a better understanding of how a system that combines videoconferencing and a shared physical tabletop space can be leveraged to support remote parent–child interaction.

There have been a few investigations of play over synchronous video outside of the home context. Batcheller et al. observed groups of college student playing the social game “Mafia” mediated by videoconferencing [13]. They found that play over videoconferencing was fun for participants, but introduced new challenges in terms of managing attention, signaling to remote partners, and social distance. Mueller et al. examined a class of prototypes called exertion interfaces which combine projection of full body video and computer vision techniques to allow remote partners to play sport-like games together [122]. They discovered that exertion interfaces have a great potential to create and strengthen social bonds between adult strangers. Both the technology and the study design of these two investigations has helped inform the work in my domain. However, neither of these investigations took place in the home nor explore the use of synchronous communication technologies with children. Extending this work into the home domain is one of the contributions of this thesis.

### ***3.4 Designing for the Parent–Child Relationship***

Designing for parents and young children requires a different approach than doing so for friends or adult family members due to the asymmetry in goals and needs between the parent and child, the challenges posed by the cognitive and emotional limitations of young children, and the focus on play and care rather than direct communication.

Work in designing for parents and children draws from past research in supporting close relationships. The Mediating Intimacy project investigated the role of technology in personal and intimate communication [179]. Cultural probes, interviews, and focus groups were used to document expressions of intimacy between family members. Simple expressions of affection within notes, emails, and mobile technology carried weight because they were used regularly and reciprocally. Such exchanges might have seemed trivial to outsiders, but they were laden with emotional significance for the participants. This study informed much of my work but did not speak to the unique nature of the parent–child relationship; while strong-tie relationships often involve symmetric goals and an equal involvement in relationship maintenance, the parent–child relationship is characterized by asymmetry. Dalsgaard

et al. extended this work to parents and children by deploying cultural probes in conducting contextualized interviews with members of three families [42]. They found that the parent carried a greater responsibility over maintaining the relationship by creating a setting for trust and unity, providing care, and participating in play. Children rarely verbally expressed affection and self-disclosed less than their parents desired. Modlitba & Schmandt conducted semi-structured interviews with five families in which one or both parents traveled frequently for business (five mothers, three fathers, and six children ages 4–10) [120]. They found that parents and children have different emotional responses to separation; children are likely to experience anxiety before the parent leaves, whereas the parent is more likely to experience a sense of guilt during the absence. I conducted semi-structured interviews with five children, five residential parents, and five nonresidential parents from divorced families to understand the challenges that they faced in maintaining closeness [188]. Sharing on the part of children was oriented toward the current moment; if they were unable to share something when it occurred, they were unlikely to remember to do so in the future. On the other hand, parents were more concerned about interrupting the routines of the other household and were unlikely to contact the child spontaneously. In investigating the needs of work-separated families, I found other asymmetries [187]. For example, parents focus on combining scheduled synchronous and spontaneous asynchronous communication to maintain a constant presence in the life of the child; children, on the other hand, focus on other sources of social support, on other activities, and on the eventual reunion. Previous work has explored asymmetric interfaces and asynchronous interaction as potential strategies for addressing this characteristic of the parent–child relationship [190]. Additionally, the context of the parent–child separation also influences the available strategies for staying in touch. For example, in work-separated families, both the remote parent and the child rely heavily on a collocated adult to maintain awareness and contact, but there is no such expectation in divorced families [187]. Both of these interview studies are discussed in more detail in the following chapters.

Designing for children holds another challenge: the child’s cognitive and emotional limitations sometimes make long-distance contact difficult. As the child develops, he or she can



begin to separate mentally from the here and now to imagine past and future events, comprehend how others see the world, and understand representational images of the world [37]. Modlitba found in their interviews that it might be difficult for a young child to visualize where their parent is traveling and how long he or she will be away [120]. Preschool children in interviewed families required the assistance of a colocated caregiver to initiate and make sense of their interaction with the remote parent. Another limitation is that children have a limited capacity to handle changes in their routine, so transitions often bring about separation anxiety and unsettled behavior for the child [94, 120]. Lastly, children have limited attention resources and motivation for remote contact, so families often find it difficult to keep a remote communication session engaging enough to hold the child’s attention [12].

One of the distinctive characteristics of the parent–child relationship is that closeness is built more through play and care together than through conversation. Perhaps this is unsurprising, since children have been shown to spend less than a one hour per week participating in “household conversation” but more than 20 hours per week participating in playing, reading, studying, and hobbies [80]. Dalsgaard et al. found that parents and children build intimacy through care and play [42]. Children and parents participate equally in mutual play, collaborative activities (doing a puzzle, reading, or cooking together), playing with shared artifacts (action figures or a board game), and physical play behaviors. On the other hand, care is unidirectional from the parent to the child and includes activities such as setting rules, providing resources for learning, giving physical care, and assisting with everyday tasks and activities. In separated families, the nonresidential parent rarely has an opportunity to contribute to the child’s care in these ways [63]. I found that this might be in part due to the difficulty of maintaining awareness of the child’s state and activities while apart [188]. Development literature emphasizes the importance of parental involvement in both care and play activities, to build secure relationships [94]. My goal as a designer is to create technologies that support parents and children in achieving both types of interaction.

### *3.5 Specific Contexts of Parent–Child Separation*

One of the arguments articulated in this thesis is that the specific context of the parent–child separation influences the strategies used to maintain contact and the challenges faced by families. In this section, I provide a brief review of work in social science domains that articulates some specifics of different types of separation.

Divorce has received a considerable amount of attention in psychology and sociology. These studies often focus on understanding the predictors and consequences of divorce. Amato [4] conducted a meta-analysis of research on divorce in 1990s to find that while divorce usually has negative consequences, these can be moderated by the distributed parent staying instrumentally involved in the child’s life and with the presence of proper social and emotional support. Furthermore, Seltzer and Bianchi [158] showed that the quality and quantity of contact with the distributed parent decreased dramatically after the first year of separation. One of the reasons they cited for this loss of contact was geographic separation. Furstenberg and Nord [63] studied patterns of parenting after separation to show that the distributed parent was likely to be involved socially in the child’s life, but rarely set rules or assisted with care activities such as helping with homework. Sviggum [167] provided a more phenomenological perspective on how Norwegian children perceive their parents’ divorce. She showed that many children worried about losing contact with the distributed parent and some viewed themselves as a bridge between the two sides of a divorced family. The studies presented in this thesis are informed by this previous work, but distinct from it in that I focus exclusively on families in the United States and in that my explicit objective is to inform the design of technologies to support parent–child communication in divorced families.

Studies of parent–child separation due to work have often focused on the effects of military deployment. Kelley et al. have shown that children in deployed families are more likely to exhibit clinical psychological problems [93]. Another study of separation has also showed separation to be a cause of short-term distress for both the parent and the child [151]. However, this previous work points out that temporary separation from either parent does not lead to permanent negative consequences for children. In supporting work-separated

families, I am focusing on addressing the in-the-moment distress that separation causes for families. These previous studies were conducted to investigate correlations between separation and children’s outcomes. In contrast, in this thesis I am interested in examining the qualitative experience of separation for parents and children and the specific strategies that these families use to manage separation.

There are many other possible context for separation that I have not covered in detail in this thesis: incarceration, immigration, hospitalization, boarding school, and more. For example, incarceration is a major cause of parent–child separation in some communities. Separation due to incarceration frequently results in long-term adverse effects on the child (e.g., [123, 136]). There are few opportunities to continue meaningful parent–child context during incarceration, despite the fact that continued contact is typically associated with positive outcomes for both the parent and the child [73, 123].

Each of these contexts is defined by unique challenges and opportunities. I provide a more detailed comparison between divorced and work-separated families based on the findings of my investigations in chapter 5. The context of the separation frequently determines the long-term effects of the separation on the parents’ and children’s wellbeing, the availability of infrastructure, the role of large institutions in supporting contact (e.g., prison system, military deployment base, divorce court), and the expected role of other adults in supporting the remote contact. In this thesis, I focus on expanding the community’s understanding of two contexts of separation, but my future investigations may include other contexts as well.

### **3.6 Conclusion**

First, it is clear that communication technologies for families have been of interest to HCI researchers for more than a decade. However, the majority of explorations in this domain have focused on asynchronous communication. While synchronous remote contact has received a lot of attention in the past five years, very few investigations have created prototypes robust enough for field deployment. One contribution of my thesis is providing such a field deployment of a novel synchronous communication technology for families.

Second, my review highlights the importance of understanding the specific context of a communication system's use. Work done for the office domain cannot always be applied to the home. Work focusing on connecting adults cannot usually be applied to understanding communication with children. Additionally, the specific context of parent-child separation influences the challenges faces by these families and the opportunities for design. Thus, another contribution of my thesis is providing a better understanding of the communication needs in two specific contexts—divorced families and work-separated families. In the next two chapters, I expand on this contribution by presenting investigations of these two different contexts of remote parent-child contact.

## CHAPTER IV

### MEDIATED PARENT–CHILD CONTACT IN DIVORCED FAMILIES

I interviewed 10 parents and 5 children to get a qualitative understanding of the challenges faced by these families and the role of technology in maintaining contact.<sup>1</sup> I found that both parents had a strong need to maintain autonomy in raising the child, though the residential parent had more opportunities to be instrumentally involved. Both parents and children sought to manage tensions between the two households—parents by reducing interruption of the other household, children by trying to keep contact with the other parent as private as possible. My participants used the telephone as the primary means to stay in touch while apart but expressed dissatisfaction with the limits of audio-only communication. It was difficult to keep a phone conversation engaging—both parents and children instead sought ways to maintain contact through shared activities and routines but found little technological support to do so while separated. Situated in these results, I present implications for design that may aid in creating technologies for communication between parents and young children in divorced families.

#### **4.1 *Motivation***

Millions of families worldwide are affected by divorce every year [4]. Though the legal definition of divorce, the culture regarding parental separation, and the custody customs vary significantly throughout the world, the consequences of a parent and a child living apart seem to be similar despite the heterogeneity of circumstances. Children in divorced families score significantly lower on measures of academic achievement, conduct, psychological adjustment, self-concept, and social relations than children in intact families [3]. A meta-analysis of divorce literature from the 1980s and 1990s shows that despite the creation of social programs to support divorced families and the fact that divorce is increasingly

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<sup>1</sup>This work was originally published in the *International Journal of Human Computer Studies* [188]; Denise Chew and Kurt Luther contributed to the analysis of the interview data.

common, children’s scores have not improved [3]. Having both parents participate in the upbringing of the child is related to positive outcomes such as academic success and emotional adjustment [15]. However, typically, the non-residential parent’s involvement tends to be limited. Current visitation practices (i.e. short or infrequent visits supplemented by phone contact) make it difficult for the non-residential parent to contribute equally to raising a child [182]. Furthermore, a large proportion of distributed parents (25%) are geographically separated from their children by a significant distance, making contact even more difficult [55]. A variable that has not been studied is the degree to which the different communication technologies are supportive of the communication between parents and children in divorced families. In this work, I examine the challenges in communication between parents and young children in divorced families in order to inform the design of technologies to support them. I begin with an overview of my method and demographics of the participants. I present the major themes that resulted from my interviews in clusters focusing on the unique characteristics of divorced families, the challenges parents and children face in maintaining communication, and current technology use. Finally, I discuss how the results of my interviews can inform the design of technologies for divorced families.

## **4.2 *Methods***

I interviewed fifteen children, residential parents, and non-residential parents from divorced families to gain a better understanding of the challenges they face and how they perceive their relationships with others in the family. I selected the semi-structured interview as a method, because I was interested in getting a phenomenological understanding of the experiences of the participants and the meaning that they make out of these experiences. In the next subsections, I present my participant demographics, discuss my procedure, and give an account of my analysis.

### **4.2.1 *Participants***

I interviewed ten parents and five children (ages 7 – 14) about their experiences. I recruited divorced families through word-of-mouth and postings in the volunteer section of a popular local online classifieds site (craigslist.org). My call requested participation of divorced

#	Gender	Age	Profession	Classification	Children	Marital Status	Visitation
P1	Male	47	Lab Tech	Secondary	11 Female	Divorced	Every weekend
P2	Male	44	Entertainment Company Director	Secondary	10 Male 11 Female 23 Female	Remarried	11 Female: summer 1 month 10 Male: every other weekend
P3	Female	34	Social Worker	Primary	<b>7 Male (C1)</b>	Divorced	Only summers apart
P4	Male	47	Professor	Secondary	5 Female	Divorced	Every day, but no nights
P5	Female	44	Reporter	Primary	<b>14 Male (C2)</b>	Remarried	Only 3 weeks during summers apart
P6	Female	33	Researcher	Primary	7 Female	Separated	Only apart every other weekend and 1 holiday
P7	Male	41	Quality Control Analyst	Primary/Secondary	<b>12 Female (C3)</b> 16 Male 17 Male	Divorced	12 Female: once a week, 1 holiday Males: only apart every other weekend
P8	Female	44	Teacher	Primary/Secondary	6 Male <b>9 Female (C4)</b>	Divorced	Every other day
P9	Female	44	Nurse	Primary	<b>12 Male (C5)</b>	Divorced	Only summers apart
P10	Male	46	IT Professional	Secondary	8 Female	Divorced	3 days a week

**Figure 2:** Demographics of parents, including whether he or she is a primary caregiver, ages of children, and visitation arrangement for each child. The child that I interviewed is highlighted in boldface.

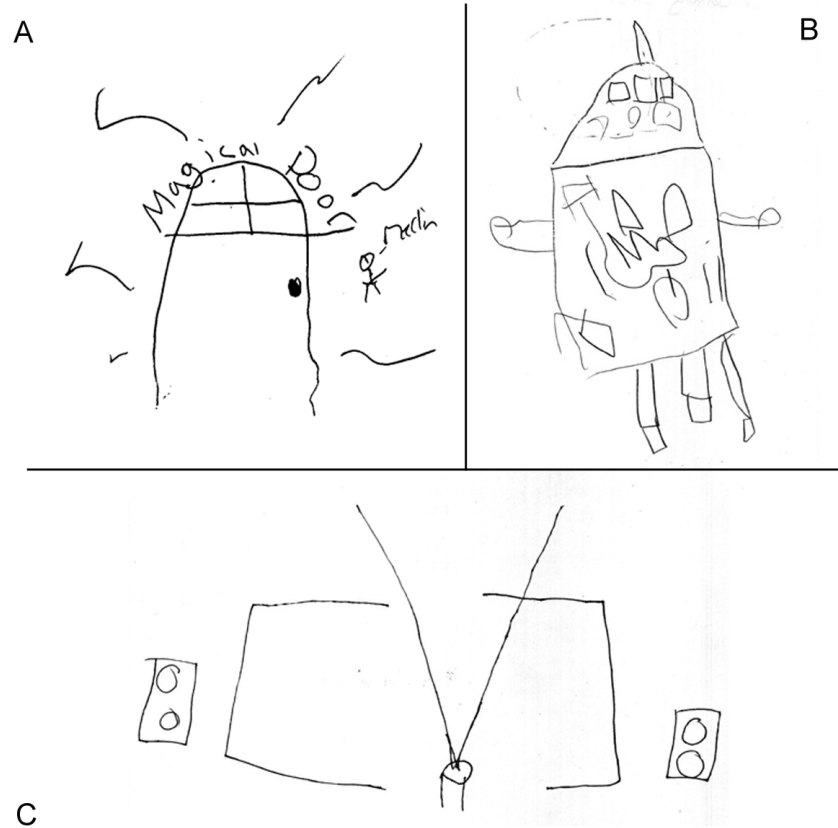
families where the child had contact with the distributed parent at least once in the last month, but I did not mention a specific custody arrangement. Out of the responses to the recruitment call, I selected an equal number of residential and non-residential parents because I wanted to get both perspectives on divorce. I also tried to select families that would represent a wide range of ages, professions, family structures, and visitation strategies (see Figure 2). I considered selectively recruiting for a specific variable (e.g., only families that have been separated for less than one year, or only families with a weekend-only visitation arrangement, or only 8- to 10-year-old children), but decided that I could provide a richer set of design implications by trying to get an understanding of the broader problem space. The heterogeneous nature of the investigation highlights the variety of possible family arrangements and may assist designers in selecting an appropriate subgroup to focus future inquiry.

There were some limitations of my recruitment approach. First, since I did not compensate families for participation, a selection bias was likely. The families that I interviewed were highly motivated to disclose and seemed to have previously reflected on the challenges of maintaining contact. On one hand, this allowed me to get an in-depth understanding within the relatively short interview process; on the other hand, it means that my participants may not be representative in some regards. Another limitation was my reliance on an Internet-based approach for recruitment, which may have led to the exclusion of lower-class families who do not have Internet access. I attempted to recruit families from a lower socioeconomic bracket by distributing fliers at a local night trade school, but was unsuccessful at attracting participants through this approach. Thus, all of my families ranged between lower-middle class and mid-upper class, and all parents interviewed had at least one year of education after high school.

#### **4.2.2 Procedure**

I asked the participants to speak with me in 30-minute semi-structured interviews. Each conversation was audio recorded and transcribed. Except for one parent–child pair, interviews of parents and children were conducted in separate rooms. Participants were asked to select a comfortable location for the interview—11 of the interviews were conducted in the participants’ homes, 2 at their offices, and 2 at local coffee shops. Parents were asked to fill out a brief demographics survey (documented in Figure 2). During the interview, I asked questions that focused on the way the parent and the child interacted in person and apart, technology they used (if any) to support their interaction, and the perceived challenges of staying close. At the conclusion of the interview, I asked the parents to describe a hypothetical future technology that families ten years from now could use to stay in touch. Children were asked to draw and describe a magical device that would make it easier to stay in touch with their parents (see Figure 3). These exercises were not meant to generate actual ideas for future technologies, but rather to serve as a talking point and a way of getting the participants to think concretely about their needs. In most of my interviews with children, I found it difficult to get the children to elaborate on answers to the protocol





**Figure 3:** Children’s drawings of magical objects to help them stay in touch with their non-residential parents: (a) a magical door that lets the dad enter the child’s room to say good night; (b) a robot for carrying secret messages between a boy and his father; and (c) a system with speakers and a holographic projector that lets the parent and child speak whenever they want.

questions during the initial part of the interview. However, as they were sketching their designs and explaining them, I was able to return to the questions and get much more detailed responses. I use some of the sketches generated by these results to highlight the perceived challenges in the interaction between parents and children in divorced families.

The main limitation of my method was that it restricted me to a relatively small set of participants. As such, I could not make claims about how all families experience divorce, but rather I sought to provide qualitative insight into common themes by exploring accounts from 10 different families. I recruited 10 families because I was informed by previous work suggesting six to twelve interviews as an adequate quantity to achieve saturation (the point when no new themes are observed in the data with subsequent interviews) [72]. However,

I must note that conducting a larger-scale study would allow for statistical analysis and would be necessary to permit future investigators to make more confident claims about the prevalence of these themes. Second, due to the heterogeneity of my sample, future work that focuses on a specific subset of divorced families may be able to yield additional themes and highlight the role of specific family characteristics. Lastly, the accounts of important stakeholders such as stepparents and siblings were outside the scope of this work, but may be a fruitful area for future study.

### **4.2.3 Analysis**

The interview transcripts were analyzed by creating thematic connections using a data-driven approach [155]. Statements of interest were extracted from each interview and grouped together by theme. With each pass through the interview data, these were refined until a set of distinct themes emerged. Two investigators completed five separate passes through the data to generate the final set of themes. Two other investigators coded a single segmented interview (randomly selected from the fifteen interviews) for these themes. The Cohen's Kappa value of agreement between the two coders was 0.79 (for 35 statements), which is classified as substantial and almost perfect agreement [105]. A second investigator then proceeded to code the rest of the interviews. In the next section, I discuss these themes, grouped into subject clusters.

## **4.3 Results**

I present my themes and the supporting evidence for each theme in topical clusters. First, I discuss how parenting in divorced families is different from parenting in intact families. Next, I put forward the challenges in maintaining communication experienced by parents and children in divorced families. Finally, I discuss the communication technologies used by parents and children in divorced families.

### **4.3.1 Redefined Parenting Roles**

In divorced families, each parent essentially functions as an autonomous unit, setting his or her own expectations and routines for the child. The amount of time the parent spends living

in the same household with the child influences the amount of care versus play behaviors that characterizes his or her relationship with the child.

#### *4.3.1.1 Each Parent Functions Autonomously*

While the child is staying with one of the parents, that parent becomes the autonomous caretaker of the child, with very little input from the ex-spouse. One of the fathers (P2) described a sense of being a “single parent” while the child is visiting because of being responsible for every aspect of the child’s life. Parents are protective of maintaining autonomy in their household. One of the mothers (P3) described that if she tried to inquire about the specifics of the father’s parenting patterns “he’d be like, ‘You don’t need to be all in my business like that.’” I asked the parents how they agree on rules for the child or what happens when they disagree. Consistent with other divorce literature, these families followed the model of “parallel” parenting [63]. Nine of the ten parents voiced some variation of “the days that she’s with mom, mom decides, and days she’s with me, I decide,” with very little communication between the parents about the child’s activities. It is interesting that this model applied to so many of my participants despite the variety of visitation strategies represented.

#### *4.3.1.2 Residential Parent More Likely to Make Rules and Provide Care*

Consistent with the previous findings of Seltzer & Bianchi’s (1988) large-scale survey study, I found that the non-residential parent is more likely to have recreational contact with the child while the residential parent is more likely to make rules and provide care [158]. To build on this work, I was interested in getting qualitative insight on how parents reasoned about this division of responsibility.

Six of the parents made statements that were consistent with the idea that this difference was mostly due to the timing of the visitation:

“...he’s with his father just on fun days, I’m primarily responsible for, you know, schoolwork and trying to give good guidance and discipline.” (P3)

Since non-residential parents were more likely to get the child on weekends and holidays, they were less likely to have to worry about instrumental concerns and more likely to

be concerned with entertaining the child or being “the Disneyland dad,” as one of the participants (P5) described.

This distinction created a tension between the residential and the non-residential parents. Three of the five residential parents that I interviewed said that they missed having more fun times with their kids when “you’re not constrained by schoolwork and things like that” (P3). One of them (P6) resented that “he’s the fun household and I’m the strict household, so it’s not as exciting to call me.” On the other hand, all of the non-residential parents I interviewed felt that they did not have enough instrumental input into their child’s life and felt that their ex-spouses had more influence. As one of them (P1) said: “It’s equal rights, but she has tie-breaking authority... So really, she can make unilateral decisions.”

Both residential and non-residential parents experienced periods of separation while the child was visiting the other household. In the next section, I describe some of the challenges that parents face in maintaining communication with the child while they are living apart.

#### **4.3.2 Communication Challenges for Parents**

When away from the child, parents experience serious barriers to maintaining communication, particularly in terms of staying aware of the child’s activities, contacting the child without interrupting the flow of the other household, and finding topics for conversations.

##### *4.3.2.1 Staying Aware of the Child’s State and Activities*

Parents in my interviews expressed staying aware of their child’s state or activities as a major difficulty of being apart: “... the hardest thing is getting her to tell me about what’s been going on” (P6). Another parent described a common exchange over the telephone:

“Right now I’m like, ‘Hey, how are you doing? What you up to? Doing anything fun?’ you know, and sometimes she’s up for answering it, sometimes she’s not.”  
(P8)

One parent highlighted this point when asked to imagine a future technology that she may use to keep in touch with her daughter:

“... I could just kind of get a little bit of a chronicle of what her activities were ... like if she traveled more than a couple of miles from where I know she’s going to be, if I had an idea of where she went so that I could see, ‘Oh she was at her grandparents today and maybe they went to the pool.’” (P6)

Two other parents also requested similar variations of GPS technologies that would let them view a “snapshot” of their child’s day.

These findings are consistent with some of the psychology literature. Dalsgaard et al. found that parents seek more self-disclosure than children usually provide [42]. In intact families, parents usually have other sources of information about the child’s activities such as contact with the child’s extended social network (friends, teachers, family, etc.) and ambient awareness from co-habitation (e.g. dirty shoes may suggest a shortcut through the woods on the way home from school). The divorced parent is forced to rely mostly on the child for receiving this information [158].

#### *4.3.2.2 Connecting without Interrupting*

Initiating direct conversation while the child is at the other parent’s household often has a high threshold for parents. One parent (P5) describes that the hardest part of her son being at his father’s “is definitely holding myself back from calling him every day.” One consideration is not “interrupting the flow of the other household” (P10). Another parent was more concerned about how her daughter would interpret frequent interruptions while at her dad’s:

“... you don’t want to be communicating to them like, ‘You can’t have fun when you’re with your dad.’ You want it to be like: ‘You know what, I’m thinking of you. It’d be really nice if I could be with you, but I’m not, so I’m just thinking about you.’” (P6)

Lastly, two parents mentioned that unless they call at an established time they have trouble maintaining the child’s attention span for a reasonable amount of time. Most common time to try to contact the child is at the end of the day, as one parent (P10) explained: “I wait till the evening before bedtime, knowing she’s home. Activities should be done. It should be the point at which it’s the least interruption.” One parent imagined a different solution:

“... on your watch you could have like a little red button and it would have like an ‘M’ on it for mom, and it would light up and he’d know that mom was trying to talk to him and he could push a button and be like, ‘Hey mom, what’s up? I’m at the pool.’” (P5)

Parents desire a more lightweight means of communicating—something that would let them check in without interrupting.

#### 4.3.2.3 *Seeding Conversation*

While apart, parents usually find it difficult to find meaningful topics for conversation with the child. One parent (P2) acted out a typical conversation with his son:

“I get on the telephone:  
‘Hi, [Calvin], how are you?’  
‘Good.’  
‘What’d you do today?’  
‘Good.’”

Without the common reference point of everyday activities parents have to expand a lot more effort in getting the child involved in the conversation:

“I have to reach out more ... I’d like to have something to talk to her about, because we don’t have any common point of reference ...” (P6)

Three of the ten parents admitted that they were not able to consistently find topics for conversation while apart. As one (P9) of them said, “I get my two-minute phone call once a day ... I think I save anything meaningful for when we are together in person.” However, one of the children described a successful strategy for seeding conversation that worked for his father:

“We always do The Book of Questions. It’s obviously like it says, a book of questions, but the questions are provoking, and it would get you into a conversation for a long time before you realize that you just had a 45 minute conversation on a question that took you five seconds to read.” (C2)

The Book of Questions was a creative way on the father’s part to manage one of the challenges of maintaining communication. In the next section, I discuss some challenges that children face.

#### **4.3.3 Communication Challenges for Children**

Children sometimes need to manage the competition between parents over their affection and time. They lack the private and uninterrupted space for conversation that intact families experience over the dinner table or in the car. Finally, there are few venues for children to share thoughts and feelings with the distributed parent as they occur.

#### *4.3.3.1 Mediating Competition over Time and Affection*

Parents often compete over the child's time and affection. Children recognize this competition and have to manage their communication in such a way as to mediate it. Eight out of the ten parents I interviewed admitted feeling a sense of competition over the child. One of them (P6) said: "It's like a double-edged sword. You want them to have fun, but not too much fun without you." Seven out of these eight parents thought that their child was probably not aware of this competition. However, I found that children were aware of it. When asked about what was most difficult about staying close to both parents, one child answered:

"... My mom has a way to make her voice sound like she doesn't care, but at the same time, you know that it's not true, and it really always hurts to hear that voice. And whenever I want to call my dad she always uses it saying, 'Oh, so you're calling him?'" (C5)

Another child brought up a similar concern:

"Sometimes my dad doesn't always like it [when I call mom], because he's like, 'You're here. You should be talking to me.' And when I'm at my mom's it's pretty much the same, except she tries to conceal it more than my dad does." (C2)

This is consistent with the findings of Sviggum that some children in divorced families see themselves as a bridge between the two parents [167]. They desire to maintain the affection of each parent without hurting the other parent's feelings.

#### *4.3.3.2 Lack of a Private Space*

I asked children where they tend to have their best talks with their parents and why they thought those places were so effective. I found that cars were the most effective places for conversation. One girl (C3) explained: "on car rides, I think because you're isolated and together, you tend to have great conversations." When asked about what made the car ride different from other moments together at home, she elaborated that it was easier "because everyone else doesn't have to hear it."

In another family, the child (C4) explained that she would often hesitate to share meaningful information with her mother while staying with her dad: "It could maybe be more

private ... then you don't have to worry about someone overhearing you..." A seven-year old child (C1) highlighted the importance of maintaining privacy between him and his father when I asked him to draw a magical artifact that would help him stay in touch. Figure 3b shows the robot that the child invented to carry messages between him and his dad. He emphasized that only his dad would be able to access these messages. For children in intact families, the home is a place of security and trust [42], but children in divorced families find it challenging to create a similar space in either household.

#### *4.3.3.3 Sharing Thoughts Spontaneously*

As I discussed in a previous section, communication between the parent and child while they are apart is often initiated by the parent at a predetermined time. This presents a challenge to children for whom it is much more natural to share thoughts as they occur. One child (C3) said that often in the day she would "see stuff and say, 'Oh, that reminds me of my dad.'" However, by the time her dad contacts her in the evening, she says that she is likely to have forgotten the thought.

Similarly, a child (C5) said that even though he may be thinking about his mother while apart, he finds it hard to interrupt his activities to call her: "I'm having so much fun there, I don't always remember." One child (C2) explained that the real issue was that he just wanted to say "I'm thinking about you" without having to start a long conversation. Both he and his mother described a technological solution they have come to depend on to address this challenge:

"... he'll call and leave a message directly on my work mailbox. Like, 'Hi, mom. We're at the airport. I'm having fun. I hope you get this message when you get back to work.'" (P5)

A seven-year-old boy reported trying to call dad immediately when he is missing him or thinking about him, but finding it really frustrating if the dad doesn't pick up or if there is no connection:

"I'd say the hardest thing would be probably when I want to call him and the phone will be not working. I'll be like, 'Man!'" (C1)

In the next section, I present some challenges of maintaining communication that affect both the parent and the child.



#### 4.3.4 Challenges for Both Parents and Children

Asymmetric access to technology infrastructure limits the contact between parents and children to the lowest common denominator. This is often audio-only communication, which both parents and children find problematic. With such restricted options for communication, non-residential parents and children in divorced families find it more difficult to create shared frameworks of meaning and maintain shared routines.

##### *4.3.4.1 Asymmetric Access to Infrastructure*

One of the challenges of long distance communication is that both parties must have access to similar resources, otherwise only the lowest common technological denominator can be used. A father mentioned that he would want to set up a videoconferencing system with his daughter over the summer, but could not do so:

“A laptop wouldn’t be a problem, but nobody in that part of the country where she is in the summer, nobody has an Internet connection...” (P1)

One of the children I interviewed mentioned that he would love to spend time together with his father online, but cannot do so:

“I guess because my internet is AOL, like, negative 4.0 ... It’s really just the fact that I don’t have some resources that I do at my dad’s.” (C2)

Other times, asymmetric access to infrastructure is not due to a difference in resources, but a difference in rules between households. A father explains:

“His mom will not allow him to use the computer. It’s only the telephone ... When [Calvin] is here, he can access his own email account and he writes her.” (P2)

He followed up by expressing his frustration that “paranoia” over the child’s safety online often prevents “really great tech stuff from getting used.”

##### *4.3.4.2 Audio-Only Communication is Difficult*

Differences in resources and rules between households often reduce the available modalities of contact to audio-only. Parents and children both expressed a great deal of frustration with audio-only communication. One father (P7) said that in person, his interaction with his

daughter depended on “her ability to see [his] expression, and her ability to remain connected with doing something that is fun.” Another father agreed that the fun and lightheartedness of his communication with his son was lost when audio was the only available channel:

“You can’t really even joke with him unless you say ‘I’m kidding.’ Unless you tell him, ‘I’m about to tell you a joke.’ Or ‘I got a good one for you.’ A lot is lost in the expression translation.” (P2)

One of the children (C2) I interviewed said that not being able to see his father was the most frustrating aspect of their current contact. When asked to invent a magical device for helping them stay in touch, he drew a system consisting of speakers and a holographic projector that would let him see and talk to his dad (Figure 3c).

Another parent (P4) mentioned that his connection with his young daughter was very “tactile.” While he immediately rejected the idea of “some sort of a robot hugging her,” he thought about the possibility of future technologies that incorporate that modality:

“... there could be things that can convey this idea of tactile, like a bear that she could snuggle with. Or maybe a sense of motion like a swinging chair. Or a sense of warmth or squeezing.” (P4)

#### *4.3.4.3 Maintaining Shared Routines*

Nine of the ten parents I interviewed reported that while having to spend time apart, they miss the daily routines or special rituals that they develop with their children. For example, one parent (P4) said:

“...We really like reading together. We call this ‘shnoogling.’ She leans against my shoulder and I put my arms around her and hold the book so we can both see it, and then we read.” (P4)

One of the children (C5) mentioned that he missed his bedtime rituals with his dad the most. When asked to invent a magical artifact to help him stay in touch with his dad, he drew a magical door that would let his dad travel instantaneously to his room to read him a story and tuck him in (Figure 3a).

Some children and parents described creating a proxy as one strategy for maintaining a routine. For example, the parent who described “shnoogling” with his daughter mentioned thinking about recreating the contact in another way:

“There could be a comfy chair and if we sat in that chair when we were together, she would feel like we are together if she sits in that chair later.” (P4)

Two of the children mentioned that when they particularly miss their parents, they often reenact the rituals with a proxy. For example, a boy (C1) who prays with his mother every night before going to sleep, mentioned setting up a photo of her near the bed as he prays. Another boy (C5) mentioned playing soccer with his father every day before dinner when together. While staying with his mom, he tries to play soccer with his friends before dinner with the same ball to feel closer to his father. This supports previous findings that children may turn to physical artifacts like photographs and shared toys when they miss a parent but cannot enter into direct contact [167].

#### **4.3.5 Current Use of Technology**

The telephone was the most common mode of communication used by parents and children to stay in touch over distance, but my participants reported that it was not effective at creating the sort of closeness they valued. Many of the children in my study did not have their own mobile phones, limiting my investigation of this modality. Videoconferencing was seen as a promising alternative to the telephone but one that was hampered by challenges to widespread adoption by divorced families.

##### *4.3.5.1 Telephone Widely Used, But Not Effective*

Every child and parent I interviewed mentioned using the phone to stay in touch. The amount of contact by phone among my participants ranged between daily and twice a month; conversation lengths ranged between two and fifteen minutes. However, I found that the phone is responsible for many of the challenges in communication between parents and children, such as the ability to be overheard, not wanting to interrupt activities, and difficulty of audio-only communication. More importantly, parents reported that the phone was just not effective at encouraging deep conversation. One father explained:

“She really doesn’t like talking on the phone. She sometimes talks, but in a very socialized kind of way. She may even appear chatty, but she’s not actually being authentic to the way she usually communicates. It’s not a deep communication.”  
(P4)

Nine of the ten parents I interviewed expressed that the phone was effective to check in or say a “quick good night” but ineffective in getting “to have an in-depth conversation.” One child (C5) admits that when he’s talking on the phone, he usually thinks “this is boring for both of us.”

#### *4.3.5.2 Mobile Phone Use Limited*

The two oldest boys (C2 & C5) were the only children in my study who owned mobile phones. While both of these boys reported using text messaging to communicate with their friends, neither used this mode to communicate with family members. As C5 stated, “I don’t think grown-ups really ‘get’ texting.” I acknowledge that this finding is likely biased by the fact that my participants were all residents of the United States where mobile telephony and SMS traditionally have had lower penetration. For example, at the time of this study, only a third of U.S. children ages 8 - 12 reported owning a cell phone [118], compared to 56% of Italian nine- and ten-year-olds [29].

Several of the parents I interviewed worried that a mobile phone could be detrimental to their child. For example, one of the fathers (P1) was considering buying a cell phone for his twelve-year-old daughter. The number one concern for him was that it should not be “an open phone,” but one with limited possible contacts that he defines, so that she would never get contacted by a stranger. One of the mothers (P9) mentioned that she had gotten her son a cell phone only on the condition that she could “check and see who he’s called and see what he’s texted.” The oldest child in the study (C2) reported that while his mother did not check his phone directly, she would carefully examine the monthly bill (which lists all numbers called) and ask him about any unusual activity. This suggests that the ability to set limits on the use of a mobile phone is an important feature for parents.

#### *4.3.5.3 Videoconferencing Effective, But Not Widely Used*

To overcome the challenges of audio-only communication some of the parents explored videoconferencing as a channel. Four of the parents I interviewed stated that they have tried to use videoconferencing to stay in touch with their children while away. Only one of these parents mentioned using videoconferencing more than five times. He stated that he

finds it much more effective than the phone:

“... she goes, ‘I’m good dad. Look at this. I’m just wearing this new outfit.’ Or ‘I just got this new thing for my room,’ and she takes the camera and shows me.” (P2)

The other three parents agreed that video was compelling, but mentioned that the difficulty in arranging and setting up the videoconferencing prevented them from using it often. One parent (P10) pointed out that it tended to be an option reserved for longer distances or times of separation: “...video calls is the third [way I get in touch], when I’m out of the country for three weeks, or something...” One of the parents (P6) reported that she was less likely to use videoconferencing because she felt that she needed to “arrange the situation” before using it: “It’s a little more personal. I don’t feel like I can do it just anywhere.”

Concern over the child’s safety was a factor that prevented some families from adopting videoconferencing. A mother (P8) stated that she would love to have some form of a “video-phone,” but only if it was a “special linked device between children and parents.” She was hesitant to introduce a device that would let her son and daughter contact (or be contacted by) anybody without restriction.

## **4.4 Discussion**

In this section, I review my findings through the lens of identifying tensions in the individual goals of members of divorced families and then present the implications for design that emerged from this work.

### **4.4.1 Tensions in Individual Goals**

The themes I identified suggest that members of divorced families balance two major goals: reducing tensions between households and maintaining closeness. Children may try to reduce tensions by keeping the details of their involvement with the other parent as private as possible. Parents may seek to reduce conflict by maintaining only minimal contact with each other, respecting each other’s autonomy, and minimizing unscheduled interruptions of the other household. However, both of these goals may conflict with the parents’ desire to remain aware of the child’s everyday activities to provide support and drive conversation.

The parent’s need to minimize interruption may also clash with the child’s goal of achieving spontaneous contact, as it leads to a regimented schedule of interaction with few opportunities for spur-of-the-moment conversation. Both parents and children expressed that they would prefer to stay in touch through shared activities and routines rather than phone conversations, but found that asymmetric rules and access to infrastructure between households often led to the lowest common technological denominator. While the non-residential parent may be driven to upgrade the infrastructure, there is often little motivation for the residential parent to do so. The residential parent may see the introduction of a new communication technology as a violation of their autonomy in raising the child or as serving to increase the imbalance in social versus instrumental contact between the two parenting parties (since most technologies support remote communication rather than remote care activities). While all parties share the common goal of achieving positive outcomes for the child, they may disagree on what constitutes a “positive outcome” and how to get there.

Researchers in this domain acknowledge that divorce is an emotionally charged topic that is difficult to explore without “being identified as either a conservative or a liberal voice” [3]. Working closely with divorced families, there is implicit pressure from the participants to ally with a particular party. In the following implications for design, I try to remain consistent with the shared goal of providing positive outcomes for the child. However, I must acknowledge that it is possible that introducing new technology in this domain may lead to unintended consequences. Before exploring concrete directions for design, I discuss the assumptions implicit in such interventions.

One assumption that I make in suggesting designs for long-distance communication between parents and children is that both the divorce and the subsequent geographical separation are inevitable for a lot of families. This could turn out to be self-fulfilling prophecy—better options for long-distance communication could lower the threshold for separating or moving away. I also make the assumption that contact with both biological parents is beneficial to the child. While there is a large body of empirical evidence to support this hypothesis [3, 94, 182], this will not be true for every child and every parent. As with any divorce situation, it becomes the responsibility of policy makers, judges, and parents to

tailor a solution appropriate to the specific situation. The most tentative assumption that I make is that improving communication between the child and the distributed parent will not negatively affect other family relationships in the child’s life. There is evidence that quality contact with the biological parents does not negatively affect the child’s relationship with their step-parents [63]. However, there is little evidence on how such contact could affect the amount of conflict between parents or relationships with step- or half-siblings. It is difficult to predict the way new technologies will affect the lives of users, though explicitly including non-user stakeholders in the evaluation of new communication technologies may help develop an understanding of such conflicts when they do occur. Keeping these assumptions and limitations in mind, in the remainder of this section I present six implications for designing technology for divorced families. I connect each implication to themes from the interviews and highlight some challenges the designer may face.

#### **4.4.2 Implications for Design**

In this section, I make suggestions for designers and future investigators of technology for distributed parenting in divorced families.

##### *4.4.2.1 Create Opportunities for Distributed Parent to Provide Care*

Affording the distributed parent with opportunities for instrumental contact could serve to relieve the tension between the parents over the disparity of providing for the care versus play needs of the child. There is evidence that instrumental involvement of both parents correlates strongly with positive outcomes for children [3]. Currently, there are few options to provide care without living in the same household with the child, however there is a clear opportunity to do so with homework. To enable the parent to assist the child with schoolwork, designers could create access to shared spaces online or augment real world spaces with access to digital artifacts. The challenge lies in enabling easy transitions between the physical artifacts of homework that the child possesses (e.g., textbook, worksheet) and digital versions of these artifacts which the parent can retrieve.

#### *4.4.2.2 Make It Easy To Find Topics for Conversation*

I have shown that one of the greatest challenges faced by parents in divorced families is staying aware of the child’s life enough to be able to start and maintain meaningful conversations. Providing the parent with better awareness of the child’s activities allows the parent to seed communication with topics more relevant to the child. Bentley & Metcalf [18] and Mynatt et al. [124] explored how sharing ambiguous information such as geographic motion or motion activity within a home can provide family members with topics for discussion and a better awareness of each others’ states. The challenge for the designer is conveying information that would provide the most descriptive power for parents while respecting the other household’s privacy. Another strategy for supporting communication is providing parents with scaffolds to structure their conversation with their child (similar to the way one father used a book of premade questions). An awareness system could support this by flagging moments of interest in the collected data to provide sharing suggestions for immediate conversation starters.

#### *4.4.2.3 Leverage Asynchronous Communication to Increase Contact*

Parents and children may desire contact with each other at inopportune times and may not want to interrupt their own or the other’s activities. One solution may be a mobile device that would allow users to capture notes to share later. If the device is small and convenient enough, and paired with items that children already carry a significant portion of the time, it would not require the child to interrupt their current activity to find a telephone, thus lowering the threshold of capturing a thought for future sharing. These messages would not be shared immediately, but rather transferred to a drop-box that could then be accessed at an opportune time. The ASTRA system provides a good prototype of this sort of interaction [117]. Their evaluation showed that asynchronous communication allowed for a feeling of closeness without creating extra social obligations. However, neither ASTRA nor other messaging systems were created specifically for children. Children may need additional motivations to encourage them to leave messages for parents and to access messages that parents have left for them—creating these motivations is one of the challenges



the designer will face.

#### *4.4.2.4 Lower Threshold for the Child to Self-Disclose*

I discussed two aspects of long-distance communication that limit a child's self-disclosure: the lack of a private space to talk and the inability to share thoughts spontaneously as they occur. Designers could take steps towards creating this private space by combining modalities that cannot be "overheard," such as video with text chatting. They could also increase the amount of self-disclosure from the child by letting him or her record a thought or feeling immediately as it occurs. For example, designers could create small mobile devices that store a single digital image and several minutes of audio to gift to the parent at a later time. They also may be able to provide additional impetus for the child to self-disclose by including ludic motivations for information sharing, such as by incorporating data from real-world sensors into an online game played by the parent and child.

#### *4.4.2.5 Make Use of Proxies When Contact is Impossible*

I showed that in the absence of direct contact with the parent, proxies can serve a powerful role in maintaining shared routines and creating closeness. When the recipient of a communication is unavailable for direct contact, designers could still provide some of the benefits of getting in touch by leveraging these proxies. For example, if the child attempts to connect with the parent through videoconferencing but the parent is not home, the screen could display photos of the parent and child together or play back a specific message from the parent, rather than simply failing to connect. A proxy could also consist of knowing that both family members are engaging in the same routine while apart, as in the case of playing soccer before dinner. Therefore, another way of increasing closeness may be letting the parent and child know when they are engaged in the same activity.

#### *4.4.2.6 Design for the Child's Autonomy*

Children are aware that their parents compete over their affection and thus do not want to have to ask one parent for help in getting in contact with the other parent. One of the reasons that videoconferencing has not become widely adopted by these families is because

the system is complex enough that it requires both parents' involvement to arrange a chat session. Designers could design technology that is as easy to operate as an appliance, by pushing a single button, in order to allow the child to immediately communicate with the distributed parent. To ensure that such a technology provides an acceptable guarantee of the child's security, these communication devices could be linked exclusively to each other—dedicated to communication between the two households. In the case of divorced families, it makes sense to sacrifice flexibility for simplicity and security.

#### **4.5 Conclusion**

In this chapter, I argue for the necessity of designing technology for parent–child communication in divorced families. I show that these families exhibit dynamics that are different from intact families and face challenges in communication that are not addressed by current technology. While I cannot predict how new technologies will be adopted by divorced families, I present implications for design that may aid in creating better-situated interventions. Empirical evaluation is the only way that these implications can be assessed, so subsequent chapter of this thesis involve building and deploying a system that incorporates many of these suggestions.

The contributions of this work are threefold. I call attention to supporting divorced families as a potential domain of interest to HCI researchers and designers. I use the results of interviews with parents and children from divorced families to highlight the challenges faced by these families. Lastly, I provide concrete recommendations for designing systems in this domain.

## CHAPTER V

### MEDIATED PARENT–CHILD CONTACT IN WORK-SEPARATED FAMILIES

As a follow-up to my investigation with divorced families, I wanted to better understand other contexts of parent–child separation as well. Parents and children in families living with regular separation due to work develop strategies to manage being apart. I interviewed 14 pairs of parents and children (ages 7 – 13) from work-separated families to understand their experiences and the strategies that they use to keep their family together.<sup>1</sup> In this chapter, I introduce this investigation, discuss my findings, and contrast the needs of work-separated families with the needs of families separated by divorce.

#### **5.1 Motivation**

Families are increasingly living with the challenge of regular separation due to work. Taking the United States as an example, 3.6 million Americans live in a different city from their partner due to work, a 53% rise since 2003 [35]. Additionally, many families with young children are affected by long-term separation due to military deployment [50]. Increasingly, work-separated families look to communication technology to support continued contact during the separation [35] and there has been a great deal of interest in the HCI community in designing for family communication [43, 57, 120, 142, 178, 189]. However, there has been relatively little work exploring the current parenting practices of work-separated families, especially taking into account the perspectives of both the parent and the child. I conducted a qualitative investigation of the experiences of work-separated families with 14 pairs of parents and children. Two research questions drove my work:

- How do parents and children respond to work separation?

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<sup>1</sup>This work was originally published at CHI 2011 [187]; Fatima Boujarwah contributed to the analysis of the interview data.

#	Interviewed Parent (Traveling)	Children [Interviewee]	Collocated Adult	Periodic Separation	Long-term Separation	Most Used Technologies
1	37F - Recruiter	6M, [7M], 13M	Father	3 days/week	-	phone + video chat
2	43F - Personal Assistant	3M, [13F]	Adult Cousin	2-4 days/week	-	phone + SMS
3	36F - Army Pilot	[9F]	Father	-	1 year	phone + email
4	39M - Army	[10M], 17M	Mother	-	1-2 years	phone + email
5	39M - National Guard	[8F], 10M	Mother	1 week/month	1 year	phone + SMS
6	48F - Research Scientist	[12F], 15F, 16M	Brother	6-8 weeks/year	-	phone + video chat
7	48M - Professor	7F, 10M, [12M]	Mother	3 weeks/year	5 months	phone + video chat
8	44M - Marketer	[11M], 14M	Mother	10 days/month	-	phone + SMS
9	42M - Manager	6F, 6M, [8F], 10M	Mother	1-2 weeks/month	-	phone
10	51M - Manager	[10F]	Grandmother	10-20 days/month	-	phone + video chat
11	46F - Manager	[11F], 13M, 14M	Father	1-4 days/week	-	phone + SMS
12	42M - Military Tech	5F, 6M, [9F]	Mother	1 week/month	1 year	IM + video chat
13	47M - Student	12F, [13M], 15M, 17M	Mother	-	2 years	phone + SMS
14	40M - Instructor	[11F]	Mother	-	1 year	phone + IM

**Figure 4:** Work-separated families participating in the study, including the ages and genders of participants. I specify whether the family experienced periodic separation, long-term separation, or both.

- What are the strategies used by these families to stay in touch and what are the limitations of these strategies?

Aside from addressing these questions, there are two other goals of this work. First, I want to expand the current understanding of the experiences of separated families, particularly in contrasting work-separated families with other types of separation. Second, by highlighting the limitations of current strategies, I hope to point out opportunities for new designs that are grounded in existing practices.

I begin by describing my interview methods and participants. Then, I present the results of the study with regard to the two research questions above. Finally, I discuss the results of this work in the context of previous work in this field and point to opportunities for both future research and design.

## 5.2 Methods

I conducted in-depth semi-structured interviews with parents and children from work-separated families.

### **5.2.1 Participants**

I interviewed parent–child pairs from 14 different families separated by work, speaking to the traveling parent and one of their children (selected by the parent) between the ages of 7 and 13. I wanted the children to be old enough to be able to reflect on their experience, yet young enough to be considered a child rather than a teenager. I looked for families that spend on average at least five nights per month apart or had recently (less than six months ago) returned from a separation that was longer than two months. Recruiting was done through word-of-mouth, ads on craigslist.org, and through local military support organizations. Figure 4 contains detailed descriptions of the participants. Throughout this paper, I attribute quotes to specific individuals by using the family number followed by “P” for parent or “C” for child. I continued recruiting families until I felt that I had approached a point of data saturation. A post-hoc detailed analysis of the interviews revealed that all of the major themes pertaining to my research questions were represented in the first seven interviews, thus there is some support for the claim that I did indeed reach data saturation for my purpose.

### **5.2.2 Procedure**

I conducted hour-long semi-structured interviews with each participant. All of the interviews were conducted in-person in a location familiar to the participant (typically, their home) with the exception of interview 13P, which was conducted over videoconferencing. Parents and children were interviewed separately, though in eight out of the 14 families the parent remained in the vicinity of the interview and was able to hear the child’s responses, which may have potentially affected the child’s answers. The questions focused on the participants’ general experiences with the separation, how they manage contact during separation, and how they use technology to stay in touch. I also asked each participant to talk about whether he or she was generally happy with the amount of contact they had with their partner. Lastly, I asked a series of more specific questions about their experiences with the two most common technologies they use. I found that participants had no trouble reflecting upon their long-distance communication routines and practices explicitly,

because many of these involved problem-solving and complex coordination by the families. Nonetheless, I acknowledge that an inherent limitation of the interview method is that it may not get at some of the more tacit communication routines in the home.

### **5.2.3 Analysis**

I audio-recorded and transcribed all interviews. The interview transcripts were analyzed by creating thematic connections using a data-driven approach [155]. Statements of interest were extracted from each interview and grouped together by theme. With each pass through the interview data, these were refined until a set of distinct themes emerged. To demonstrate that an independent rater would code the data in a similar fashion, I computed an inter-rater reliability metric. An independent coder and I coded three randomly-selected segmented interviews for these themes. The Cohen's Kappa value of agreement between the two coders was 0.85 (for 76 statements), which is classified as outstanding agreement [105]. Any disagreements on codes were discussed until consensus was reached. I then proceeded to code the rest of the interviews using the agreed-upon scheme.

## **5.3 Results**

My results focus on two research questions. How do parents and children respond to being separated by work? What strategies do these families use to manage separation and when do these strategies fail?

### **5.3.1 Responding to Separation**

Parents and children respond to the separation in different ways. For the parents, the focus is maintaining an active role in the child's life, while children try to spend time with collocated adults and focus on the eventual reunion.

#### *5.3.1.1 Parents Seek Active Contact Remotely*

Nine out of the 14 parents made comments about wanting to remain an important, active part of the child's life while away.

"I guess just try and let your kids know that you're still there; you're still a part of their lives; that you haven't really gone; not to worry about you." (4P)

“Just ‘cause they know that you’re there and you still care and that you’re part of their life. ‘Cause they get busy too and they’ll... out of sight, out of mind.” (8P)

Parents maintain contact by initiating either synchronous or asynchronous communication (I discuss this in more detail in a later section). They describe their most meaningful conversations while apart as having to do with learning about the child’s day and finding opportunities to provide support:

“She was complaining about something her teacher had done. And I called to say that I hope her day gets better.” (6P)

Additionally, parents spent much of their time away thinking and talking to others about their children:

“I talked about her a lot. I would talk to other people about her. It just made me think of her more.” (3P)

“I got into the habit of quite liking thinking about what to buy them ... I suppose it’s a way of thinking about them when I’m away.” (9P)

Nine other parents also mentioned acquiring physical and digital artifacts during their travels to share with the child. It seems that while away, parents dedicate a lot of thought and energy to the separation. However, it is also important to acknowledge the experiences of the other five parents, who did not emphasize the importance of contact while apart. For all five of these families, separation lasted no more than a week. These parents mentioned relying on the collocated adult to take care of all childcare matters while they were away, but spending more time with the children upon their return. Interestingly, this strategy seems to be more in line with the way children manage separation, as I discuss next.

#### *5.3.1.2 Children Focus on In-Person Interaction*

Unlike the parents, children think of separation in terms of the eventual in-person reunion, rather than focusing on maintaining instrumental contact while apart. The most meaningful conversations for children were ones that focused on the reunion:

“What we were going to do when he got home, planning different restaurants that he hadn’t been able to go to, what games he hadn’t been able to play with us, stuff that he hadn’t been able to do that was one of the first things we wanted to do when he got home, looking forward to getting home.” (12C)

Ten out of 14 children mentioned being comforted by “counting down the days” (3C) as the most important topic of conversation with the remote parent while they were away.

Physical objects representing the remote parent seemed to be a big component of how children handle moments when they miss their parent.

“He gave me a medallion with a picture of us before he left, so I can know that he’s right next to me ... I wore it all the time.” (4C)

“We had daddy dolls. One that was a pillow that was actually a human shape that had a full body picture of him. And so I would sleep with those at night or whatever when I missed him.” (12C)

As an interview strategy, I asked the interviewees how they would advise other children in handling separation from their parents. Rather than dealing with the separation by advising actively seeking a connection to the remote parent, children advised focusing on the eventual reunion, spending time with other family members, or finding other distractions:

“I’d probably tell them that they’re not going to work there indefinitely, because that helped [me] a lot.” (3C)

“You should spend time with your mom when your dad’s away and spend time with your dad when your mom is away.” (9C)

“Maybe try to like think about other stuff. Like try not to think about that. Sometimes like watching TV gets my mind off of it.” (8C)

Perhaps because children’s way of managing separation is not focused on direct contact, children were more likely than adults to be satisfied with the amount of contact during travel. Nine out of 14 children were satisfied with the current contact, compared to only four out of 14 adults. Three of the children in this study expressed some level of displeasure about being obligated to maintain contact with their parent while they travel, because it takes them away from other activities.

“Evenings is my free time and I’m usually busy with my own things. I don’t really like to spend time to chit-chat. It’s just not who I am.” (7C)

Several parents confirmed that often children are not motivated to take the time to speak to them.

“I’m calling from Iraq and he’s like, ‘Dad, my friend is here. I need to go play.’” (4P)



Again, it is important to acknowledge the experience of the four out of the 14 children, all over the age of 10, who did manage separation by actively maintaining contact. Three of these children had been living with regular separation due to work for more than two years. I saw evidence that willingness to actively communicate is related to the personality of the child, his or her age, and the opportunity to practice communicating while apart.

### **5.3.2 Strategies for Managing Separation**

Through my interviews, I identified five specific strategies used by parents and children to manage separation due to work. For each of these strategies, I discuss the reasons for employing this strategy, the number of families in this study that have attempted this strategy and the number that use it regularly, and the limitations of this strategy that may be addressed with new technology.

#### *5.3.2.1 Scheduled Synchronous Contact with the Home*

It is not surprising that all of the families in this study maintained contact through synchronous technologies like the phone and videochat. My contribution is identifying two specific characteristics of this synchronous contact that were shared by many families: the contact was scheduled and it consisted of the remote parent contacting multiple members of the household in a single call. For most of the families I spoke to, typical synchronous communication consisted of the remote parent contacting multiple members of the household during a pre-established window of time by either calling the house phone or contacting the collocated adult first.

“I’ll call home every night and then it just kind of depends on who’s here.” (9P)

“I’ll call and see whoever answers, and they’ll say, ‘Oh, do you want to talk to so and so,’ and I’ll talk to each one for a little bit. But if somebody can’t talk, that’s okay.” (6P)

Only two families reported that their typical synchronous contact that did not exhibit these characteristics—family 13 only made sporadic unscheduled contact and family 8 contacted each household member individually rather than calling the house.

There are three advantages of this strategy. First, it allows the remote parent to schedule the interaction at a time that doesn’t interrupt their work.

“A lot of times I feel like I’m interrupted, you know. Like I’m in the middle of something and the phone rings and I’m like, ‘Oh geez, I’ve got to answer.’ I’m much more of ‘Okay, we’re going to talk at this time. Set it up.’” (7P)

Second, it limits interruption of individual activities of those at home, because only those who are available to talk participate.

“They also have lots of activities, so it’s too hard to try to figure out when they might be available. I just call at a certain time and whoever can talk talks.” (6P)

Lastly, it allows multiple members in the household to participate in the conversation at the same time, which leads to a sort of synergy and generally a more fun experience:

“Whenever someone else is talking, like my sister or my brother, we all just have fun, like sometimes I put rabbit ears in front of the other person to make my mom laugh and stuff.” (6C)

“We’ll say something like an inside joke, and she’ll laugh. And my brother, he’ll say something weird. We don’t know what he be saying, but we just laugh.” (2C)

However, there are also three limitations that this strategy creates. First of all, because the interaction is driven by the parent, the child sometimes does not feel empowered to initiate contact:

“She usually calls us because we don’t know what kind of meeting she’s in right then or something.” (6C)

Second, it put the remote parent into the difficult position of coming up with regular topics for conversation:

“They don’t like me to call every day because I ask the same questions ... I’m forcing myself to be a part of their life when they don’t really have anything new to talk about.” (4P)

Lastly, four of the 14 households no longer had a communication device shared by the household (e.g., house phone) so the act of “calling home” must be mediated by the collocated adult. This can reduce contact with the child if the collocated adult is unavailable or unwilling to talk. I discuss this issue in more detail in a later subsection.

### 5.3.2.2 *Spontaneous Asynchronous Phatic Communication*

Thirteen out of the 14 families attempted to supplement the scheduled synchronous contact with spontaneous asynchronous communication over mail, email, or SMS. Eleven of these 13 families used asynchronous communication regularly. Eight of the parents explicitly mentioned that sending an asynchronous message was the way they dealt with moments when they miss their child. Asynchronous communication was usually targeted individually at the child:

“I’ll flood her box with a bunch of e-mails and send her animation things. And sometimes, I may just overnight her something in the mail. I mean, to get something with her name on it blows her away.” (10P)

Rather than focusing on instrumental concerns, asynchronous contact was usually phatic in nature—focused on reinforcing the social bond rather than providing information [115].

Two children describe their emails to their parents:

“I always use big letters and say I love you. They take up like half of the page. I used to make these little smiley faces and I’d put them on there. Then I’d put like a little background.” (3C)

“I wouldn’t talk about how I’m feeling, I would just use a lot of those smiley face pictures.” (4C)

SMS messages were often focused on conveying a sense of connection rather than practical information exchange.

“Oh, I’ll send her little smiley faces or little messages. Little special, you know, songs or little gifts through the phone.” (2C)

“I’ll just send him a text and say, ‘Hey, I’m thinking of you. Hope you’re having a good day’ type thing.” (4P)

Phatic communication was the rule for most of the families who communicated asynchronously (except families 6, 8, and 11, who also used asynchronous communication for instrumental purposes). There are two limitations of this strategy. First of all, the only form of asynchronous communication available for individual use with younger children is mail, because they often do not have phones or email accounts. That makes it difficult for parents with younger children to enact this strategy. Four parents mentioned struggling with the idea of buying their child a cell phone to allow them to send messages to each other,

but not feeling that the child was ready for the responsibility of owning a phone. The second issue is that asynchronous communication offers limited opportunities for emotional expressiveness—a major limitation since it is mostly used for phatic messages.

“...with email, sometimes you will sanitize it a bit; like you’re feeling really sad but you don’t want the person to know how sad you are.” (3P)

“...you can’t really, like, feel someone’s emotion that they’re, like, feeling. Like if they don’t want to talk about it then you don’t know what we’re going through.” (8C)

### *5.3.2.3 Enlisting the Aid of a Collocated Adult*

All of the families in this study talked about seeking help from a collocated adult during the separation. For children, this was the most listed strategy for managing separation:

“If one of your parents is gone and stuff, then start to talk more to the other parent too about how you feel and stuff.” (6C)

“She would, you know, would be there and like talk to me, tell me that he’d be home soon, that it’s all right.” (12C)

For parents, the collocated adult is not only a source of emotional support, but also the major mechanism by which they stay in touch with the child. The collocated adult serves as an awareness system about events in the child’s life and encourages the child to speak to the remote parent:

“It’s [my wife] I’m always phoning ... she’d always make sure that they come to the phone, you know, talk a little bit ... And she recounts what’s been going on, especially if there’s anything around school or behaviors or something.” (9P)

“If something comes up, she’ll just normally send it to me on email while she’s thinking about it. And then when I get to email, I’ll have four, five, six emails waiting on me, and just get caught up that way” (5P)

Additionally, the collocated parent supported technology use by helping set up any technology involved in the communication and motivating its use:

“He would make videos with her, so he would actually set up the camera and everything and they would make videos together to send to me, which she couldn’t have necessarily done on her own at that time because she was little.” (3P)

However, two of the families in my study were unable to use this strategy routinely: one (family 2) because the collocated adult was a distant relative unmotivated to maintain contact and one (family 4) where there was frequent marital conflict between the parents.

These examples point to the limitations of this strategy. Even in families that are usually cooperative, there may be times that the collocated adult may be unwilling to participate fully:

“There were times when, if my husband and I weren’t getting along ... he was short in answer and so then I’m only able to email with her and that was very upsetting.” (3P)

In other situations, the collocated adult may be willing to support the communication but may not have the technical competency to do so in the most effective way:

“...because of her lack of technology awareness, she hasn’t really helped too much...” (4P)

Lastly, in six of the families parents expressed concern over the additional responsibilities that their absence introduced to the collocated adult and wanted to limit this overhead.

#### *5.3.2.4 Using Videochat*

I discuss the practices of using videochat separately from the synchronous communication practices highlighted in the previous sections, because using videochat had a different effect on satisfaction with contact than other types of communication. I did not explicitly recruit for families that use videochat, yet nine of the 14 families had attempted to do so and five out of those families used it regularly. As in the previous investigations of videoconferencing [6], my participants described a number of advantages over the phone, such as being more emotionally expressive, leading to longer conversations, and allowing show-and-tell:

“She’s always showing me something new she got, something she made in school. So it’s really, really fun.” (10P)

The availability of video seemed particularly important to parents during longer separations:

“If I had not done the video, it would have been when I left in June till December when I saw everybody ... So I don’t know that I would have recognized them if it hadn’t been for the video as often as it was.” (12P)

Videochat seems to be an effective strategy for staying in touch. Eight out of 10 participants who used videochat routinely were satisfied with their overall contact with their remote partner, whereas only six out of 18 of those who didn’t use videochat reported being satisfied with the overall level of communication (80% vs. 33%). So, why is it that so few families

use it routinely? I discovered three major limitations of videochat that prevented it from becoming used routinely. First of all, setting up videochat is still a major barrier for families because it requires at least one knowledgeable user at each location who is willing to deal with the setup overhead:

“You know if I was to be here and try to get a video call done ... I just know that it’s gonna be fraught with problems. It’s not gonna be simple. Something is gonna be wrong ... It doesn’t just have an on/off button.” (9P)

Second, for a relatively large number of families videochat was simply unavailable because they did not have the necessary infrastructure such as a computer (family 2) or a reliable Internet connection (families 3, 4, 5):

“When we were deployed, the bandwidth wouldn’t support it and it would lock up, and you’d end up getting madder about the whole thing. We tried to use it and it just wasn’t reliable. So that’s the only experience I’ve had with it.” (5P)

Lastly, whether for technical or social reasons, videochat requires a dedicated time and place for the interaction. Several families mentioned that they used the phone more than videochat because it supports multitasking:

“If I’m on the phone I could be washing the dishes, or doing other things that are mindless; whereas with Skype I can’t be doing that because they’ll notice.” (13P)

“I can walk with [the phone]. That’s what I can’t do as easily while I’m Skyping.” (6P)

For others it was because the video-chat-enabled computer was often placed in a location usually used for work or rest rather than a living room.

“I think it’s because she has to be upstairs in her bedroom ... And she’s not in her bedroom unless she’s going to bed.” (10P)

“We’re supposed to be on the computer at the same time, which usually can’t happen because I’m not in the [home] office that much.” (13C)

Many families viewed videochat as something only worth attempting on special occasions. For casual communication, they did not want to “make a big deal of it” (9P) and often used the phone instead.

#### 5.3.2.5 *Playing Online Games*

Four out of the 14 families attempted to incorporate some form of online gaming into their contact while apart, but only two families used online gaming regularly. Three of these families tried synchronous casual online games and one tried asynchronous gaming through Facebook.

Family 12 found online gaming to be so important that they switched videochat clients to one that provided a larger variety of games. The games that they played online became part of their in-person interaction as well:

“We would play backgammon or Chinese checkers ... That was excellent. We even bought a Chinese checkers game after I got back home.” (12P)

However, there are a number of challenges to incorporating online gaming into long-distance interaction. First of all, children do not necessarily want to see their parents involved in every game space:

“I don’t want to play online games with my dad. I more like to play on my own.” (14C)

One avid World of Warcraft player rejected the idea of using it to stay in touch with his dad:

“That’d be kind of weird. I would feel like he’s watching over me.” (4C)

Second, when gaming is a synchronous interaction, multiple children may want to participate at the same time. However, currently multiplayer games are usually set up to allow only one player per computer. So, while children will often talk to their parent all at the same time, they have to take turns in order to play with their parent.

“I think there was a couple of games where you could play with more than two players ... But we didn’t do that often, because we don’t have another computer at home.” (12C)

Lastly, when playing in-person, parents often have the responsibility of motivating the game and guiding the younger players. This is very difficult to do with online games, so younger children may quickly lose interest in the game:

“I try to do some kind of chess play you know, that kind of thing, but with them is a little difficult because they are still learning ... we tried to do a Monopoly game one day but it was very slow, the thing is he gets bored.” (1P)

There was less interest in playing online games together than may have been observed in previous work (e.g., [125]).

## **5.4 Discussion**

In this section, I put this investigation in the context of other work in this field and point out some opportunities to further investigate and support work-separated families.

### **5.4.1 The Unique Situation of Work-Separated Families**

While work-separated families share some challenges and needs with other types of parent-child separation, there are some unique aspects to their situation. I considered the results of interviews with divorced families [188, 131] to better understand the similarities and differences between divorced and work-separated parent-child contact.

On first examination, the situation of work-separated families is not in as much need for intervention as the situation for divorced families. In work-separated families, reintegration is assumed, so many families are willing to put up with non-optimal communication technologies as a temporary solution. At least some of the parents and the majority of the children are willing to minimize long-distance interaction with the understanding that a forthcoming reunion will provide better opportunities for staying in touch. Overall, nine of the children and four of the adults in my study were satisfied with the currently available methods of communication. However, there is a class of families that seems to be consistently unhappy with the available options for communication. Out of the eight military family interviewees, only one was satisfied with the amount of contact during the deployment. So, while the overall level of satisfaction with current contact is higher for work-separated families than for divorced families, there are clearly opportunities where additional interventions would be welcome.

The second difference between divorced and work-separated families is the greater expectation of conflict in the former. Work-separated families make greater use of the collocated adult, whose cooperation is expected. The presence of this ally makes the work-separated situation easier to handle. However, my interviews revealed that even in intact work-separated families, conflict between the remote and collocated adult can limit interaction



with the child. In divorced families, this conflict is anticipated and families implement strategies to minimize the effect of this conflict on the relationship between the remote parent and the child. Work-separated families do not usually prepare alternative routes of communication and strategies for managing conflict. In this way, when the conflict does occur, its effects may be more serious.

Lastly, a big difference between separation due to work and other types of parent–child separation is the relative lack of control by the remote parent over their environment. In divorced families or other permanent separations, the parent may be more able to invest in the necessary infrastructure to support richer forms of interaction. Work-separated families may not have access to the necessary infrastructure or the influence to create such infrastructure either because their relocation is short-term or because they are in an infrastructure-poor location (as is often the case for military families [50]). Additionally, work-separated parents may have less control over their time while away for work and fewer opportunities to develop permanent social strategies for maintaining contact with their children. In essence, while divorced families may sculpt their permanent environment to support maintaining contact, work-separated families must often make do with temporary solutions that they can bring into the situation with them.

#### **5.4.2 Non-Consensus in Work-Separated Families**

Studies of communication technologies for the home often emphasize families that seek out more opportunities to communicate. It is a common trend in discussing domestic communication technology to focus on harmony and consensus. However, recent work in the HCI domain points out that conflict, disruption, and non-consensus are also part of family life and the way families use technology [46]. To contribute to this conversation, I highlight the finding that there is often a lack of consensus between parents and children in work-separated families as to what constitutes “enough” communication.

My study showed that the need to increase contact is a characteristic common of traveling parents, but less commonly seen in children. Spending more time communicating with the remote parent may in fact interfere with the strategies used by children to cope

with the separation. To them, the time is better spent connecting with a colocated adult and focusing on things other than being apart. While only three children expressed displeasure with excessive contact from their traveling parent, a number of parents expressed frustration with short conversation and single-word replies. At least one previous project has considered giving the child the power to determine the amount of communication—the eKiss system allowed only the child to send messages to the system and did not provide the parent with any means of prompting for communication [43]. They found that children did not share as much as the researcher had expected or as much as their parents had hoped. This is additional evidence that children are not as motivated to communicate as their parents may be.

In designing new communication technologies for families, designers are implicitly supporting the desires of the typical parent over the desires of the typical child. Perhaps, designers are justified in making this decision in the spirit of meeting the needs rather than satisfying the desires of the child. However, it is important for designers to consider the obligation to communicate that their system may impose on the child and what may happen if the parent’s expectations for communication are not met.

### **5.4.3 Opportunities in Designing for Separation**

There are three clear opportunities in designing for work-separated families that emerged from these interviews: designing for synchronous communication with multiple children, designing for direct asynchronous communication between the parent and child, and designing for infrastructure-poor environments.

Synchronous communication in work-separated families often occurs between the remote parent and multiple members of the household simultaneously. Videochat supports participation by multiple individuals and is reportedly used this way quite frequently [6]. However, the synchronous communication technologies that we have been designing as a community seem to focus on contact with one child at a time [189, 57, 142]. In the interviews, families talked about the synergy that occurs when multiple children are able to talk to their parent together. HCI researchers should consider placing a greater emphasis on

designing to support this configuration.

Though there have been several previous projects looking at asynchronously sending photos from a mobile device to a public display or blog [43, 117, 178], there is an opportunity to explore designing devices that allow the parent and child to exchange asynchronous messages directly. My study showed that though synchronous communication tends to occur “with the household,” asynchronous communication is often targeted directly to the child. Parents mentioned that sending a message just to the child is a way of making him or her feel special. Though cell phones currently fulfill this functionality for older children, mail is often the only available form of asynchronous contact with younger children—a clear opportunity for new designs. In creating novel methods of asynchronous communication, it is important to keep in mind that such a system would be most helpful if it provided opportunities for including color, images, and animations. The participants emphasized that these are important to the way that children express themselves in asynchronous messages.

Perhaps the biggest need in designing for work-separated families is in supporting military parents. These families face a combination of three challenges that make the separation particularly difficult: the separation is usually long-term, there is usually a significant time zone difference, and there is usually very limited access to communications infrastructure [50]. Using videochat is a key strategy for other work-separated families, but one that is often denied to this group. These families have found creative ways of appropriating communication technologies that are otherwise not very child-friendly, such as email. There is a clear opportunity to provide expressive, low-bandwidth means of communication for these families. Some of these prospects are being explored by Sesame Workshop’s Family Connections<sup>2</sup>, but there are still many opportunities for future work.

#### **5.4.4 Opportunities in Investigating Separation**

There are two directions for future investigation: studying the role of the collocated adult and further investigating the role of games in staying in touch.

The collocated adult plays a key role in work-separated families. Aside from serving

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<sup>2</sup><http://www.familiesnearandfar.org/>

as emotional support, a human awareness system, and encouraging communication, they are in the difficult position of reconciling the sometimes conflicting strategies for managing separation enacted by the child and the remote parent. Though these interviews revealed some of the responsibilities of these individuals, a follow-up study looking specifically at collocated adults in work-separated families would allow the community to better understand the challenges they face, the strategies they use, and how to support them in their role.

These interviews revealed a tension in how families use online games to stay in touch. While two families found it helpful, others rejected the idea of playing games together for various reasons. This seems contrary to the previous suggestion that activities together are a more natural way for parents and children to stay in touch than simply talking [188] and to previous accounts of families playing together online [125]. As a community, designing for remote play between parents and children has been a key approach taken by several projects [45, 120, 57], but all of these systems presented only preliminary evaluations so it is interesting to consider what would happen in a longer deployment. Our assumptions as a community about the benefit of games for connecting parents and children may not reflect the reality of long-distance parent–child interaction, so HCI researchers should investigate this in more detail. What aspects of games contribute to families adopting online gaming as a strategy for staying in touch? In what situations can online gaming be an effective strategy and in what situations do families reject it?

## **5.5 Conclusion**

When separated by work travel, parents and children adopt strategies to manage being apart. Parents often turn to synchronous and asynchronous communication technologies in order to maintain a consistent presence in the child’s life. Scheduled synchronous communication with the entire household is supplemented with spontaneous asynchronous contact with each child individually. Videochat is a successful strategy for staying in touch when it is used, but is often unavailable or impractical for regular use. Unlike their parents, children often do not seek out communication but rather focus on managing separation by spending

more time with a colocated adult. It is often up to the colocated adult to balance the gap in motivation to communicate between the parent and child. Current communication practices are meeting the needs of many work-separated families, but not the needs of military families. A designer focusing on work-separated families should consider the tension between the amount of contact desired by the parent and child, the role of the colocated adult, supporting existing synchronous and asynchronous communication practices, and designing for situations with limited infrastructure.

This investigation allowed me to examine parent–child separation from a context other than divorce. I found a rich area for future investigations that presents distinct challenges from divorced families. However, I also saw that a large proportion of work-separated families (excluding military ones) were already satisfied with their remote communication. Divorced families seemed to face communication challenges more consistently, so I saw a greater opportunity for impact in pursuing the context of divorce more explicitly in the remainder of my thesis work. However, the interviews described in this and the previous chapter highlighted for me the nuanced nature of family communication and the importance of understanding the emotional consequences of a technological intervention. In the next chapter, I describe an effort to contribute to the ongoing discussion of how these aspects may be evaluated, through the creation and initial validation of a questionnaire for measuring the affective benefits and costs of communication technologies.

## CHAPTER VI

### TOWARDS A VALID AND RELIABLE METRIC OF THE AFFECTIVE BENEFITS AND COSTS OF COMMUNICATION TECHNOLOGIES

One of my goals in creating and deploying systems for separated families is to be able to rigorously compare novel prototypes to other communication systems used by families. Through conversation with other researchers in the domain, I discovered that no validated instruments were currently commonly used in such evaluations but that the community had an interest in the development of such tools [128]. This was the main impetus for creating and validating a questionnaire to aid designers in evaluating communication technologies. This chapter presents the design and validation of a questionnaire for measuring the Affective Benefits and Costs of Communication Technologies (ABCCT).<sup>1</sup> Motivated by the need to support evaluations of technologies for intra-family communication that include also children as participants, I have developed and validated two versions of this instrument one for adults and the other for child users. I describe the pilot use of this instrument with 45 children and 110 adults, concluding that the ABCCT has acceptable inter-item reliability. I present interviews with 14 children and 14 adults, which support the validity of the instrument in that the ABCCT measures the same constructs that may emerge through an interview investigation. I show that the ABCCT has high test-retest reliability and convergent validity with the SCQ metric of social connectedness. Next, I demonstrate that the ABCCT is sensitive enough to discriminate between different communication technologies and results in findings that are consistent with previous work in the field. Finally, I discuss

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<sup>1</sup>This work is currently under review for inclusion in the *HCI Journal*. Panos Markopoulos contributed greatly to the conceptualization of this project. Fatima Boujarwah contributed to the interview analysis.

the limitations of the ABCCT and provide recommendations for using this instrument. The full text of both the child and adult versions of the questionnaire is provided in Appendix A.

## **6.1 Motivation**

Informal social communication has traditionally been supported by generic communication media originally intended for work- and task-related purposes. For example, communication for most families relies on the telephone, text messaging, and more recently videoconferencing [95]. However, since the turn of the millennium, interest has been growing regarding technologies that are aimed specifically at supporting affect-oriented communication. Related innovations often rely on conventional technologies like browsers accessed on desktops (e.g., [137]). Others develop special purpose devices that enable informal social interactions (e.g., [82, 189]). Moreover, industrial designers have been exploring how communication tied to sensing and actuating can render a wide range of physical objects into carriers and enablers of affective communication. Some of the diverse designs in this domain include the Feather, Scent and Shake [166], doll houses [59], lampshades [78], and jewelry [135].

As the field progresses from early design explorations to robust technologies intended to address specific separation contexts, the need arises to support the empirical evaluation of the emerging user experience with quantitative measures. Given its subjective nature, user experience is typically evaluated with self-report methods: interviews, questionnaires, diaries, etc. The field of HCI has thus directed considerable attention to evaluating the user experience; however efforts to develop related questionnaires have considered user experience in a very narrow sense, tied to the interactivity offered by the device rather than placing it in the context of human activity. A well known example is the AttrakDiff questionnaire that extends traditional notions of usability with the hedonic aspects of interacting with a device [77]. Valuable though they may be, such instruments and related research need to be complemented by evaluation methodology and instruments that are specific to the human activity that the interactive technology supports and that can characterize its effects in doing so. Specifically for affect-oriented communication one question that arises is: How

do we evaluate such a diverse set of ideas and associated systems to understand their effect on the users and their relationships?

Given this broader and more holistic consideration of interactive technology, it follows that traditional laboratory evaluations that have characterized much of usability oriented evaluations are of limited utility, giving way to field testing as the golden standard for the evaluation of a novel social communication system. Field deployments of interactive systems allow for “exploring user understandings, practices and the eventual uses” of the novel system [24]. In particular, field deployments of social communication systems published in the research literature typically last between 1 and 8 weeks and include between 1 and 14 households. Typically, researchers log systems use (e.g., any messages sent through the system) and interview the users before and after the deployment. This approach provides rich qualitative data about system adoption and appropriation, prompting and guiding subsequent improvements of the system. However, relying exclusively on qualitative methods presents some problems for this domain. One of the main problems is that a lack of agreed-upon metrics makes it difficult to draw generalizable conclusions across investigations, deployments, and systems (as discussed in, [128, 180]). It is difficult to compare a specific technology system systematically either to earlier technologies or to alternate versions with different subsets of features. As such, one can only theorize as to which features of a new design are effective at supporting communication, which aspects of the results reflect the distinctive aspects of the trial population, or what conclusions can be drawn by examining the sum of work in this domain. I propose that some of these challenges can be addressed by adopting a common approach for measuring the costs and benefits of communication systems, in addition to the commonly used qualitative methods.

A few attempts have been made already towards developing an instrument to allow the quantitative evaluation of affective aspects of communication technologies. These are reviewed in the following section. In this paper I present the Affective Benefits and Costs of Communication Technologies (ABCCT) questionnaire as one such potential common approach to the problem of evaluating communication technologies. Originally aimed at evaluating communication media used by children, it allows the evaluation of such media



for adults as well. The ABCCT provides the following benefits over related instruments:

- It addresses the use of the specific technology in question, rather than connectedness or relationship quality in general.
- It is applicable to both synchronous and asynchronous communication technologies.
- It contains less than 30 items, so it takes less than 10 minutes to fill out.
- It can be used with both children and adults, with preliminary reliability and validity metrics provided for both groups.
- It highlights both emotional benefits and emotional costs that a system may introduce.
- It is sensitive enough to show differences between two similar communication systems.

I developed the ABCCT questionnaire by building extensively on previous work, though collaborations with experts in the field, and through an analysis of interviews with separated parents and children. I piloted the questionnaire and tested its reliability through deployments with 45 children and 110 adults. I validated the benefits portion of the questionnaire by correlating answers on the ABCCT with an existing validated metric of social connectedness. I continued to validate the questionnaire by comparing interview data about technology use gathered from 14 adults and 14 children with their responses to the ABCCT. I also collected test–retest reliability statistics from the same sample. Though this provides only an initial reliability and validity analysis, it strongly suggests that the ABCCT is a promising metric for evaluating communication technologies.

## ***6.2 Related Work on Evaluating Communication Technologies***

I provide an overview of the current evaluation methods for social communication technologies and a review of currently available questionnaires for evaluating these types of systems.

### **6.2.1 Review of Evaluation Methods for Social Communication Technologies**

I identified 35 papers published in archival HCI venues (e.g., CHI, CSCW) that presented and evaluated novel communication technologies for families, friends, or couples (see Figure

5). While I do not claim that this is an exhaustive list of all work done, I believe that it provides a representative sample of work in this space to understand the current practices of evaluating novel social communication technologies.

A significant proportion of papers in the HCI domain present novel communication technology ideas (e.g., [53, 166]) or even novel systems (e.g., [172, 174]) but do not provide any sort of evaluation. In this analysis, I include only those papers that provide a discussion

<b>Paper</b>	<b>System</b>	<b>Participants</b>	<b>Duration</b>	<b>Methods</b>
(Bentley & Metcalf, 2007)	Sharing Motion Info	3 dyads, 1 group of 4	2 weeks	logs, interviews
(Bonanni, Vaucelle, Lieberman, & Zuckerman, 2006)	PlayPals	2 children	lab study	observations, interviews
(Brown et al., 2007)	Whereabouts Clock	5 families	1 month	logs, interviews
(A. J. Brush, Kori M. Inkpen, & Tee, 2008)	SPARCS	7 pairs of families	5 weeks	diaries, interviews, logs
(Consolvo, Roessler, & Shelton, 2004)	CareNet	4 elders + their social networks	3 weeks	daily phone check-ins, interviews
(Dalsgaard, M. B. Skov, & B. R. Thomassen, 2007)	eKiss	4 families	5 weeks	logs, interviews
(Follmer, Raffle, Go, Ballagas, & Ishii, 2010)	Video Play	3 families	lab study	observations, interviews
(Freed et al., 2010)	Videochat for Dollhouses	7 pairs of children	lab study	observations, interviews
(Gooch, 2011)	Magic Sock Drawer	1 couple	6 weeks	diaries, logs, interviews
(Steve Howard, Kjeldskov, M. Skov, Garmoes, & Grünberger, 2006)	The Cube	5 couples	6 weeks	logs
(Judge, Neustaedter, & Kurtz, 2010)	Family Window	6 families	5 weeks	logs, interviews
(Judge, Neustaedter, Harrison, & Blose, 2011)	Family Portals	6 families (2 triads)	1 month	logs, interviews
(J. "Jofish" Kaye et al., 2005)	Intimacy Bits	5 couples	1 week	dairy logbook, <b>questionnaires</b>
(Lindley et al., 2009)	BubbleBoard	5 households	1 month	logs, interviews, photos
(Lindley et al., 2010)	Wayve	24 households	1.5-3 months	logs, interviews
(Modlitba, 2008)	Globetoddler	1 family	1 week	logs, interviews
(Neustaedter & A. J. B. Brush, 2006)	LiNC	10 mothers	lab study	observations, interviews
(O'Hara et al., 2005)	TxtBoards	1 family	2 months	logs, interviews
(Plaisant, Clamage, Hutchinson, Bederson, & Druin, 2006)	Shared Calendars	3 households	2 months	logs, interviews
(Raffle et al., 2010)	Family Story Play	8 families	lab study	structured observations, interviews
(Raffle, Ballagas, et al., 2011)	Orange Toaster	28 children	controlled environment study	observations, interviews
(Raffle et al., 2011)	Pokaboo	2 families	2 months	logs, interviews
(Raffle, Revell, et al., 2011)	StoryVisit	61 families	4 weeks	interviews, observations, logs
(Natalia Romero et al., 2007)	ASTRA	2 families	2 weeks	interviews, diaries, <b>questionnaires</b>

(Rowan & E. D. Mynatt, 2005)	Digital Family Portrait	1 family	6 weeks	interviews, <b>questionnaires</b>
(Saslis-Lagoudakis, Cheverst, Dix, Fitton, & Rouncefield, 2006)	Hermes@ Home	2 families	6 weeks	logs, interviews, participant observations
(Sellen et al., 2006)	HomeNote	5 families	1 month	logs, interviews
(Spingarn-koff & Cheng, 2011)	RopePlus	2 people	lab study	observations
(Truong, Richter, Hayes, & Abowd, 2004)	Physical Connection Devices	2 people / 2 machines	>2 months	logs
(F Vetere, Davis, Gibbs, & S Howard, 2009)	Collage	1 family	8 weeks	logs, interviews
(West, Quigley, & Kay, 2007)	Memento	7 users	lab study	observations, interviews
(Svetlana Yarosh, Cuzzort, Müller, & Abowd, 2009)	ShareTable	7 parent-child pairs	lab study	observations, interviews
(Svetlana Yarosh et al., 2010)	Video Playdate	13 pairs of children	lab study	structured observations, interviews
(Zuckerman & Maes, 2004)	CASY	4 families	2 weeks	logs, interviews (w/ adults only)

**Figure 5:** Previous lab and field evaluations of novel communication technologies for the home. Those that included questionnaires are highlighted in boldface.

of a system evaluation. Of the 35 papers that provide an evaluation (see Figure 5), 10 papers (29%) reported lab study evaluations. Most papers used passive observations and interviews in the evaluation, though 2 papers [191, 142] also employed structured observation using specific validated criteria for the evaluation. Eleven papers (32%) involved field deployments of 1 – 4 weeks. All of these collected logs of system use and conducted periodic interviews with participants. Thirteen papers (38%) involved field deployments of 5 – 12 weeks. Most of these collected logs of system use and interviews with participants; two of these also collected diaries of participants’ experiences. This demonstrates the prevalence of qualitative methods as a means of user based evaluation in this field.

Only five of the studies I investigated included structured pre- and post-deployment questionnaires to understand the impact of system’s use on the social relationships of the study participants. This is surprising, because investigations of family communication in the social science domain quite frequently involve the use of validated questionnaires in addition to other methods [129]. Kaye et al. stated that “participants were asked to subjectively rate the effectiveness and level of intimacy of their current methods of communication” [92]. No other detail was provided on the questions used or the effectiveness of these metrics.

Rowan & Mynatt stated that they “attempted to measure changes of perceived awareness and connectedness by asking [participants] to rank these indicators using a Likert scale daily in their diary.” [150] Unfortunately, this metric did not yield useful results as they saw a ceiling effect. Khan et al. took measures before the introduction of their experimental system to support intra-family awareness, after a week of use, and a week after the end of this intervention [96]. They did not apply any validated instrument for the evaluation but directly asked their participants to evaluate four aspects: the reassurance it provides, how it helps them coordinate, their ability to communicate emotions, and how it helps express to the other that they are on your mind. Their results could attribute relevant benefits directly to the use of the system, but the specific questions posed would be very difficult to re-use in another context. Romero et al. report a two week deployment of an experimental system in which they compared measures prior to and after a week of using their system [148]. For the quantitative evaluation they used the Affective Benefits and Costs questionnaire (ABC-Q), a predecessor to the instrument presented here, that was developed for the purposes of that study [83]. That questionnaire had an excellent internal consistency as a whole ( $\alpha = 0.86$ ). However, the only validation was the measurements collected from 11 participants in a single case study deployment of novel technology. Though its results were not in conflict with the qualitative data collected through diaries and interviews, no quantitative measure of agreement was provided. Additionally, the ABC-Q was not appropriate for use with children who were thus excluded from the quantitative evaluation, and subsequent applications have shown it to be difficult to understand and to apply in relation to diverse technologies, making its revision necessary. This chapter presents significant changes to the original affective benefits and costs questionnaire, validates the resulting questionnaire with a more rigorous quantitative approach, and extends it for use with children.

I do not advocate that qualitative methods should be replaced or abandoned, but rather want to support a mixed methods approach. I agree with Brown et al. that field trials present inherent challenges that could be ameliorated through diversifying the methods and approaches used in understanding system use [24]. Qualitative methods provide rich descriptions of system use and point to potential areas of improvements. On the other hand,

collecting quantitative and structured data about how the system is perceived through the use of questionnaires better supports comparison between pre- and post-deployment experiences, between multiple novel systems, and between different versions of the same technology. This may be particularly important in the field of communication technology. Figure 5 reveals that participant numbers tend to be fairly small for these studies (with two recent notable exceptions [112, 145]). In order to be able to draw meaningful conclusions across systems and deployments, it is helpful to use standard methods that would allow combining and comparing data across investigations. My hope is that the ABCCT can provide one such standardized approach.

Lastly, none of the papers I have examined represented a between-participant approach. In other words, no studies in HCI have attempted to compare the use of two different social communication interventions in any way other than within subjects. This leads to possible biases in field trials where the participants try to be “good participants” by providing favorable feedback about the experimental system or changing their behavior to match the researcher’s demands [24]. In a blind between-participant study, participants would be expected to display equal demand bias towards the systems tested since they would not know if the system they are using is the experimental or the control, allowing for a more valid comparison. Creating a standardized questionnaire for understanding the costs and benefits of communication technologies may make such a between-participant approach more viable.

### **6.2.2 Using Survey Instruments for Evaluating Communication Technologies**

There are a number of survey instruments in social science that one might consider using to evaluate affective costs and benefits of communication technologies. Noller & Feeney provide a review of validated questionnaires for measuring characteristics of family communication [129]. A person’s general positive and negative affect can be measured using the Positive and Negative Affect Schedule [173]. Further, there are a number of metrics for assessing the quality of any specific relationship, such as the Quality of Relationships Inventory [139] or the Parent–Child Relationship Questionnaire [61]. One could imagine that such

measures could be taken before and after the introduction of a novel technology to evaluate its impact. However, these instruments measure characteristics that remain fairly stable over time. There is no evidence to show that any of these instruments would be sensitive enough to detect a subtle change in a relationship, communication pattern, or personal affect that may be caused by a 1 – 12 week usage of a novel communication system, which is typical and feasible for field tests in this domain.

There are a few attempts within HCI literature to design survey instruments specifically aimed at evaluating the affective aspects of communication technologies. Traditionally a focus on synchronous media and especially those intending to emulate and substitute physical co-presence of communicating parties, gave rise to the notion of Social Presence, the sensation remote communicators experience of being together. Validated inventories have been developed by Short, Williams, and Christie [161] and more recently the Networked Minds Social Presence questionnaire [76] aimed at measuring social presence in various communication technologies. These instruments have been used extensively for evaluating communication media and in a few cases also in the context of field trials, to evaluate affect-oriented communication media, as for example Romero et al. did in the context of a field trial lasting two weeks [148]. The limitations of such instruments pertain to the operationalization of social presence, which is not applicable for asynchronous systems and is not necessarily a relevant aspect of the emerging user experience when informal social media are discussed.

Recognizing this need, W. IJsselstein et al. developed the Affective Benefits and Costs Questionnaire which provides the basis for the ABCCT presented in this chapter [83]. The ABC-Q scales were identified as a result of extensive interviews, diaries, and email diary studies. The scales of the original questionnaire are the following:

**Obligations:** social obligations felt or created as a result of the communication activity.

**Expectations:** raised expectations or unmet expectations for communication.

**Threats to Privacy:** the extent to which communication threatens one's privacy.

**Thinking About:** thinking about each other and knowing one is thought about.

**Need to Be Informed:** knowledge of other people’s activities.

**Staying in Touch:** the feeling of being connected.

**Sharing Experience:** how much one feels other people are involved in his/her life, sharing experiences.

**Recognition:** the extent to which each other’s feelings are understood.

**Group Attraction:** the feeling of being part of a group.

ABC-Q was found to have an excellent internal consistency ( $\alpha = 0.86$ ) and was applied by its creators for evaluating a novel communication system, which supported the validity of the ABC-Q as qualitative data largely confirmed the quantitative results [148]. ABC-Q has been used widely in several research groups and industry projects; however it appears challenging for respondents. For example, the ABC-Q consists of 60 items which makes it too long for most studies (especially those with young children), the reciprocal items it includes require perspective-taking that is beyond the abilities of younger children, and it mixes questions regarding specific technologies with general contact questions (making it difficult to use it to compare specific technologies). These issues have resulted to the exclusion of children as respondents in studies where the ABC-Q has been applied (see for example, [148]).

The ambition to link measurement to the theoretically founded notion of belongingness [14] prompted the development of the Social Connectedness Questionnaire (SCQ) [176]. This instrument combines items of an earlier questionnaire on social connectedness and the inclusion of other in scale [10], in an attempt to measure the satisfaction of having sufficient social contact with one specific person, or with one’s social network in its totality [106]. The SCQ was conceived to be used in a similar manner to the ABC-Q: Comparing pre- and post- measures can reveal potential benefits deriving from using a newly introduced communication technology in real life for some period of time [16]. From the perspective of an interaction designer, an inherent weakness of this approach shared by the SCQ and ABC-Q is that the evaluation of user attitudes does not refer to a specific medium. In

other words, you can ask about a person’s overall connectedness experience, but not about how a specific technology has shaped that overall experience. Linking the measured effects to this technology is then an issue handled in experimental design and requires that the introduction of a novel application can make a sufficient difference even in a short period of time. Further, I note that social connectedness was originally but one subscale of the ABC-Q, measuring one of the eight potential benefits of communication media. The SCQ only evaluates this specific benefit of a new technology and is silent about potential downsides which are crucial to the designer of systems that increase social connectedness.

In summary, I can conclude that the ABC-Q as it was originally conceived is the only self-report instrument that addresses the need of the interaction designer in relation to measuring affective costs and benefits of communication technologies. It has high internal consistency but does so at the expense of its length (60 items). The limitations listed above render it inadequate for use in evaluating new media, especially when children are involved as field-test participants. The SCQ is too limited in scope, covering only one of the eight benefits originally included in ABC-Q, it is not appropriate for children participants, and it is excessively long and difficult to answer. Additionally, both instruments do not evaluate a specific technology but the attitude of a person regarding their social network or relation to a specific other.

To address these challenges I have continued the development of the ABC-Q in a different direction: (1) respondents are required to evaluate the experience of using a specific communication medium to communicate with a specific individual and (2) I have developed two versions of the questionnaire one for adults and one for children. Validating questionnaire instruments with children is a fairly new development in the field of psychometrics, as traditionally the attitudes of children have been gathered through proxies such as parents and teachers [17]. However, HCI and related fields have customarily acknowledged the value of working directly with the child (see [193]). Currently, investigations with children are generally done through qualitative methods such as interviews, observations, think-aloud, and participatory design [2]. There are few validated structured methods for gathering



children’s opinions about technology. Some notable exceptions are the three methods presented as part of the Fun Toolkit [147]. The first is the Smileyometer scale, which asks the child to rate the interaction with a particular technology on a picture-based scale of 5 smiley faces. The second is the Fun Sorter, which asks children to rank several tried technologies from best to worst. The third is the Again-Again table which asks children to say whether they would like to use a particular technology again: “Yes,” “No,” or “Maybe.” The value of these methods is that they could be employed in any technology evaluation, but this general nature also introduces a shortcoming. Each technology is evaluated as whole, making it hard to understand the pros and cons and trade-offs that exist between multiple systems. The ABCCT addresses these shortcomings by allowing children to rate communication technologies on several cost and benefit scales.

### ***6.3 Designing the ABCCT Questionnaire***

In order to design the ABCCT Questionnaire, I conducted a review of previous work looking at communication technology use in families. I worked with experts to condense and refine my scales. The resulting scales were piloted with children and adults. Most relevant scales were retained in the ABCCT, resulting in a 7-scale questionnaire.

#### **6.3.1 Generating the Scales**

I created the children’s ABCCT first and then adopted it for use by adults. Creating a survey appropriate for children forced me simplify wording and make the questions more clear. Adult participants appreciate these features as much as children do, so it was reasonable to move from the child version to the adult version. Four types of previous work were used to generate the original ABCCT scales and questions: the adult ABC-Q [83], the theoretical background provided in related literature (see Figure 6), re-coding of the interviews from a previously conducted study of parent–child communication in divorced families [188], and brainstorming by two experts in designing for social connectedness. The original drafting yielded 12 scales with at least 5 questions per scale (total 90 items).

To shorten the survey, I decided to narrow the scope of the survey to only include affective benefits and costs. As a result, the “Coordination” scale was dropped from Benefits

Related Work Legend	Scale	Evidence in Related Work
1. (M. G. Ames et al., 2010) 2. (Ballagas et al., 2009) 3. (Bonner, 2009) 4. (Caughlin & Petronio, 2004) 5. (Dalsgaard, Skov, Stougaard, & Thomassen, 2006) 6. (Dalsgaard et al., 2007) 7. (Feltham et al., 2007) 8. (Fitness & Duffield, 2004) 9. (Gardner & Cutrona, 2004) 10. (Strong & Gaver, 1996) 11. (Hindus et al., 2001) 12. (Steve Howard et al., 2006) 13. (V.-J. Khan & Markopoulos, 2009) 14. (E. Mynatt, Rowan, Jacobs, & Craighill, 2001) 15. (Olivier & Wallace, 2009) 16. (Petersen, 2007) 17. (Natalia Romero, van Baren, Markopoulos, de Ruyter, & IJsselstein, 2003) 18. (Natalia Romero et al., 2007) 19. (Saslis-Lagoudakis et al., 2006) 20. (Sellen et al., 2006) 21. (Tee et al., 2009) 22. (Tollmar et al., 2000) 23. (F. Vetere et al., 2005) 24. (F Vetere et al., 2009) 25. (Svetlana Yarosh, Chew, et al., 2009)	Emotional Expressiveness	2, 8, 11, 13, 15, 17, 23, 25
	Engagement & Playfulness	1, 2, 5, 6, 7, 16, 18, 24, 25
	Presence-in-Absence	1, 10, 12, 14, 18, 19, 23, 25
	Opportunity for Personal Effort	11, 13, 17, 18, 20, 21
	Opportunity for Social Support	5, 9, 13, 14, 15, 17, 20, 25
	Feeling Obligated	11, 18, 19, 21, 22, 25
	Unmet Expectations	4, 19, 21, 22, 23
	Threat to Privacy	3, 4, 14, 18, 21, 22, 25

**Figure 6:** Original ABCCT scales and support for each scale in previous literature.

and the “Efforts of Scheduling” and “Cost of Initiating and Composing” scales were dropped from Costs. I do think that these issues are important in how a communication technology is interpreted and adopted, but they relate to logistical rather than emotional needs. As part of future work, it would be appropriate to design a different instrument to address these aspects of communication technologies.

In the children’s version of the questionnaire, I removed any reciprocity scales and questions (e.g., “My partner worries about me violating their privacy”), because development literature shows that it is challenging for children to conceptualize another person’s world view [165]. Review and discussion of the resulting measure by 2 experts lead to eliminating 23 questions and rewriting a significant portion of the remaining questions. This resulted in a draft of the survey with 8 scales and 55 items. Figure 6 lists these original scales and related literature that supports the inclusion of each scale.

However, the reader should be aware of two limitations of this literature review. First, this review focuses on the reported costs and benefits of communication technologies used by families, rather than friends or acquaintances. The main reason for this is that there is very little work on communication technology use by children outside of the family setting. Second, this review was conducted in 2009, so there are new sources of evidence available for these scales that are not represented in this analysis. More recent publications also confirm the constructs presented through my scales (e.g., [89]), however since these publications were not considered when the questionnaire was conceived, I do not include them in the discussion of the design (however, I do reference later work in the evaluation and discussion of my findings). In order to create the adult version of the ABCCT, I added reciprocity items to the appropriate scales, slightly reworded 3 questions to reflect a more sophisticated understanding of emotional states, and added items to the “Opportunity for Social Support” scale to represent both giving and receiving support.

### **6.3.2 Piloting the Survey**

I followed Bell’s guidelines in designing and testing the children’s questionnaires, by conducting comprehensive pretesting, including cognitive interviewing [17]. To pilot the survey

with children, 3 nine- and ten-year-old boys were asked to complete the ABCCT-Child one-on-one with the researcher while reasoning out loud. By observing when the children became restless while taking the survey, I noted that it needed to be cut in size by half. The next draft of the survey restructured two of the scales and eliminated 9 questions that the children found unclear. The resulting measure was piloted with another 4 ten-year old children using a think-aloud protocol. From this pilot, the next draft had one scale eliminated, most questions refined and redundant ones eliminated, resulting in an 8-scale, 32 item questionnaire (4 questions per scale). Following, an additional deployment (see following section), factorial analysis was done on the survey results leading to one item being moved to a different scale and to the merging of two closely-related scales. Ten questions were omitted in an effort to shorten the survey and remove confusing questions. The resulting draft consisted of the 7-scale, 22-item ABCCT-Child questionnaire.

A pilot was conducted with 8 adults, asking them to complete the ABCCT-Adult one-on-one with the researcher while reasoning out loud. This led to a slight rewording of all of the questions along with removing 2 questions that seemed to be confusing to multiple participants. The changes to the survey from piloting with adults were relatively minor, as I had already worked out the majority of the problems through piloting with children. The final result was the 7-scale, 27-item<sup>2</sup> ABCCT-Adult.

### 6.3.3 ABCCT Final Scales

My process of design, consultation with experts, and piloting of the surveys allowed me to focus the survey and refine the scales to the 4 major affective benefits and 3 major affective costs of communication technologies. In this section, I provide detailed descriptions of each scale.

**Benefit 1: Emotional Expressiveness.** One benefit of a communication technology may be the ability to share emotional states with a partner. This includes both being able to express one’s own feelings and being able to perceive the feelings expressed by the

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<sup>2</sup>The final survey actually consists of 26 items, as one question was omitted to improve inter-item reliability of the Engagement & Playfulness scale (see later section)

partner.

**Benefit 2: Engagement & Playfulness.** Social communication is frequently characterized by playful exchanges and other attempts at making the communication more engaging for both partners. The ABCCT asks whether the communication via a certain medium is fun and exciting to the participant. Adults may also be sensitive as to whether the communication was engaging to their partner, so the adult version includes a reciprocity item.

**Benefit 3: Presence-In-Absence.** Presence-In-Absence is defined as the “subjective sense of social others whilst separated from them by time or space” [81]. Some communication technologies may be more suited to fostering feelings of “closeness” or “connectedness” to a partner, as well as better supporting specific behaviors like remembering a contact or frequently thinking about each other.

**Benefit 4: Opportunity for Social Support.** One of the great possible benefits of communication technologies is the opportunity to provide social support without being physically present. This includes a general sense of the other person “being there” for you, reducing negative affect (such as soothing anxiety), or increasing positive affect (such as feeling “special” or loved). This may also include more instrumental forms of support such as giving advice or helping make a decision. While social support is usually bilateral between two adults, it is often unilateral in the direction of the child. As such, ABCCT-Adult includes items about both providing and about receiving social support.

**Cost 1: Feeling Obligated.** A communication technology may introduce an unwanted obligation to connect. This may include feeling compelled to communicate or respond when you would rather not do so and even feelings of guilt over not maintaining adequate communication. The adult version of the questionnaire also includes a reciprocity item, since adults are often sensitive of situations where they might be creating obligations for others.

**Cost 2: Unmet Expectations.** A given communication technology may increase expectations for communication. When these expectations are not met, participants may experience negative affect. Expectations may include the frequency of contact, how quickly a person returns a missed contact, and how much attention is devoted to the communication. On the ABCCT, I ask only about the frequency of situations where unmet expectations actually result in negative affect. Lastly, the adult version of this scale also includes a reciprocity item, as negative emotions can result from feeling that you are not meeting your partner’s expectations.

**Cost 3: Threat to Privacy.** A communication technology in the home may be seen as invading a very private space. This scale includes three major aspects: concerns over your communication partner being able to see or hear something you may want to keep secret, concerns over others in the environment overhearing the communication, and concerns that the communication may be invading the partner’s privacy. The last aspect is another example of a reciprocity item and thus only present on the ABCCT-Adult.

## **6.4    *Methods***

I conducted three studies to gather reliability and validity measures of the ABCCT. I deployed the child version survey and discussed it in focus groups with 45 children. I deployed the adult version of the survey online with 110 adult participants. Lastly, I conducted interviews and deployed the survey with 14 adults and 14 children in families where a parent travels frequently for work. I discuss the results of these studies in the following sections. In this section, I give an overview of my procedure in each study.

### **6.4.1    Deployment and Focus Groups with Children**

Following the initial pilots described earlier in this chapter, I proceeded to test the ABCCT with a larger group of children to gather reliability statistics and to continue refining the question set (more details about this study can be found in [192]). The study was conducted at a school in Preston, England with 45 eight- to ten-year-old children participating in

testing the survey. Children were excused from class for 20 minutes in groups of 6 at a time. The survey was read aloud by the researcher to each group of 6 children as they filled it out. The children were observed as they completed the survey and confusing questions were noted. After completing the survey, each group of six was led by the researcher to discuss which questions seemed to be most problematic. From the focus group responses, the authors identified questions that needed to be reworded or removed from the survey. The survey responses were analyzed quantitatively to gather metrics of inter-item reliability.

#### **6.4.2 Deployment with Adults**

To pilot the ABCCT with adults, I created an online version of the questionnaire. A link to the questionnaire was circulated using social networking media (Facebook and Twitter), emailed to the general Georgia Tech College of Computing mailing list, and posted in the craigslist.com “Volunteer” section. Each participant was asked to fill out the ABCCT for a relationship and communication technology of their choosing. There was also a comment area where they were asked to provide general feedback about the questionnaire. A total of 113 participants completed the questionnaire. Two entries were removed from the analysis as the participants rated multiple communication technologies in a single survey instead of selecting one specific technology. One entry was removed because the participant gave the same answer to all questions and took less than 1 minute to complete the survey, suggesting he or she did not read the questions. The remaining 110 questionnaires were analyzed quantitatively to gather metrics of inter-item reliability and to understand differences in how different communication technologies were rated.

#### **6.4.3 Interviews and Surveys with Parent–Child Pairs**

The process of designing the questionnaire allowed me to make sure that the questions and scales aligned with the previous work in evaluating communication technologies. The process of deploying the questionnaire with large groups of children and adults allowed me to make sure that questions corresponded with scales in ways that I would expect and gather general comments about the face validity of the questionnaire from the target participants. However, to more rigorously measure the reliability and validity of the questionnaire, I

conducted a follow-up study with a smaller number of participants that allowed me to see how the results of the ABCCT corresponded to other measures of affects and benefits of communication technologies and see whether the results on the ABCCT remained stable over time for each participant.

#### *6.4.3.1 Participants*

I wanted to be able to gather measures about both the ABCCT-Child and the ABCCT-Adult, so I recruited families who frequently used communication technologies and who were willing to participate in in-depth interviews. Families where one parent travels for work frequently met the criteria for this study. I interviewed parent-child pairs from 14 different families separated by work, speaking to the traveling parent and one of their children (selected by the parent) between the ages of 7 and 13. I wanted the children to be old enough to be able to reflect on their experience, yet young enough to be considered a child rather than a teenager. Recruiting was done through word-of-mouth, ads on craigslist.org, and through local military support organizations.

#### *6.4.3.2 Procedure*

I conducted hour-long semi-structured interviews with each participant. The questions focused on the participants' general experiences with the separation, how they manage contact during separation, and how they use technology to stay in touch. Lastly, I also asked a series of more specific questions about their experiences with the two most common technologies they use, specifically what they see as the costs and benefits of each technology. In this chapter, I focus specifically on the costs and benefits of communication technologies reported in the interviews (a detailed discussion of my overall findings in this study can be found in [187]).

In addition to the interview, I collected several survey measures from each participant about how they used communication technologies. After the interview, each parent and child responded to ABCCT questionnaires for the two technologies they used most frequently to stay in touch. I read the ABCCT questionnaire out loud to each participant younger than 10 and recorded the answers; older participants were given the paper version



of the questionnaire to fill out independently. I also asked each adult to fill out a Social Connectedness Questionnaire [176] specific to his or her relationship with the child interviewed (unfortunately, no child version of the Connectedness Questionnaire is available). Finally, all adult study participants were contacted again two weeks after the interview and asked to fill out another version of the ABCCT questionnaire for the same technologies they had previously discussed. I also asked that each parent verbally administer another ABCCT-Child to the child who participated in the study.

#### *6.4.3.3 Analysis*

All interviews were audio-recorded and transcribed by me. The interview transcripts were analyzed by creating thematic connections using a data-driven approach [155]. With each pass through the interview data, themes were refined until a set of distinct themes emerged. In addition to this data-driven approach, I identified all statements in the interview that corresponded to any of the scales on the ABCCT. For each participant, I examined all interview statements corresponding to any of the ABCCT scales. Based on these interview statements, each participant was assigned a score of either “low,” “medium,” “high,” or “insufficient information” for each ABCCT scale. For three randomly selected participants, the lead author and an independent coder scored interview statements for each scale. The agreement between me and the independent coder was for 0.80 over the 42 codes (3 participants \* 7 scales \* 2 communication technologies). Any disagreements on codes were discussed until consensus was reached. I then proceeded to code the rest of the interviews using the agreed-upon scheme. In order to be able to quantitatively compare the results of the interview coding and the ABCCT questionnaire responses, I also classified each participant’s responses on the ABCCT for each scale according to the same scheme. To do so, I averaged the responses to all of the questions pertaining to a particular scale. If a participant averaged between 1.00 and 2.33 on a particular scale, he or she was classified as “low” on that scale; averages between 2.34 and 3.66 was classified as “medium” on that scale; and, averages between 3.67 and 5.00 was classified as “high” on that scale. Thus, for each of the 14 adult and 14 child participants, for each scale of the ABCCT, I recorded

two values: one as indicated by the participant through his or her ABCCT responses and one as coded by the researcher based on the participant’s interview responses. I treated these two values as two sources of ratings and conducted inter-rater reliability analysis to understand the level of agreement between the two measures. Any participant scales coded as “insufficient information” in the interviews were dropped from this analysis. On the adult version of the questionnaire, there was insufficient evidence for 14 out of the 190 scale-medium pairings (7.4%). On the child version, there was insufficient evidence for 29 out of the 175 scale-medium pairings (16.6%).

Lastly, I conducted a quantitative analysis of the surveys administered to these participants to get measures of convergent validity and test–retest reliability. To get a measure of convergent validity, I compared the average benefits of communication technologies as reported on the ABCCT with the Specific Social Connectedness metric of the SCQ [176]. I hypothesized that a participant that reports high level of benefits in using the group of communication technologies with a specific family member would also report having high levels of social connectedness with this family member. To get a measure of test–retest reliability, I asked study participants to fill out the ABCCT for each communication technology again two weeks after it was initially administered. I hypothesized that responses in the initial week would correspond strongly to responses in the follow-up survey deployment.

#### *6.4.3.4 Methods Limitations*

The evaluation of the ABCCT questionnaire presented here is meant to provide an initial step towards a final instrument. Though I provide several components of typical questionnaire validation, the number of participants in each part of the analysis is significantly lower than in a typical psychometrics study. For example, the PANAS affect schedule [173] was tested with an initial study of 407 participants and with a retest study of 163 (compared to 110 test and 27 retest for this ABCCT investigation). While the ABCCT approach is appropriately scaled to other validations of instruments in the HCI domain (e.g., SCQ tested with 215 participants, and provided no test–retest [176]), it may not provide as thorough a validation as a true psychometric approach. In the light of this limitation, it is important

Scale	Cronbach's Alpha
<b>Benefits</b>	<b>0.88</b>
Emotional Expressiveness	0.65
Engagement & Playfulness	0.74
Presence-in-Absence	0.71
Opportunity for Social Support	0.86
<b>Costs</b>	<b>0.80</b>
Feeling Obligated	0.64
Unmet Expectations	0.78
Threat to Privacy	0.72

**Figure 7:** Inter-item reliability metrics for the ABCCT-Child Questionnaire.

for investigators using this instrument to understand it as a work-in-progress and to use it in a manner proportionate to its limitations. This, among other reasons, is why I recommend a mixed methods approach where the ABCCT is not the only source of evaluation data for a communication system. As more HCI investigations utilize this instrument, the community may come to better understand the specific limitation it presents and which cases may require modifications of the instrument.

## 6.5 Reliability Results

In this section, I discuss the reliability of the ABCCT questionnaire. I present preliminary evidence for the internal consistency of the child and adult ABCCT questionnaires. Lastly, I discuss the test-retest reliability of this instrument.

### 6.5.1 Internal Consistency with Children

I gathered inter-item reliability metrics by piloting the ABCCT-Child questionnaire with 45 children. The results of this analysis are presented in Figure 7. Overall, the Benefits and the Costs dimensions both achieve internal consistency classified as “good” [67]. The scales for Engagement & Playfulness, Presence-in-Absence, Opportunity for Social Support, Unmet Expectations, and Threat to Privacy all achieve Cronbach’s Alphas in the “acceptable” to “good” range. However, the Emotional Expressiveness and the Feeling Obligated scales have a Cronbach’s alpha in the “questionable” range. Since there are only general rules of thumb as to appropriate level of Cronbach’s alpha and since lower values may still be acceptable for scales with a smaller number of items [130], I argue that these scales are

Question	Benefit	Cost
I felt closer to X after using the medium together.	0.867	
I could let X know how I was feeling over the medium.	0.846	
I was excited to about using the medium with X.	0.841	
I could tell over the medium how much X cares about me.	0.790	
Using the medium with X when I was having a bad day helped me feel better.	0.771	
I had fun with X while using th medium.	0.724	
I could tell over the medium how X was feeling that day.	0.672	
X made me feel special in our contact using the medium.	0.634	
I felt more connected to X after our contact using the medium.	0.633	
I felt less worried about something after using the medium with X.	0.505	
It was boring to use the medium with X. [Negatively coded]	0.430	
After we were done, I still kept thinking back to something X shared using medium.	0.410	
X was there for me over the medium when I needed them.	0.399	
I had to answer when X contacted me using the medium even if I didn't want to.		0.826
I felt sad when X didn't pay enough attention to me when we used the medium.		0.811
I had to talk to X using the medium even if I didn't want to.		0.807
I felt guilty if I didn't answer a contact X made using the medium.		0.773
I worried that X might learning something I want to keep secret over the medium.		0.482
I felt sad when X took too long to respond when I tried to contact X via medium.		0.482
I felt sad because X wasn't around when I tried to contact X over the medium.		0.462
I worried about my privacy while X and I were using the medium together.		0.202
I worried that others would overhear or see something that X and I shared.		0.274

**Figure 8:** Factor analysis of the child-version of ABCCT, showing the orthogonal nature of the costs and benefits dimensions, as well as identifying most significant questions to each dimension.

Scale	Cronbach's Alpha
<b>Benefits</b>	<b>0.88</b>
Emotional Expressiveness	0.74
Engagement & Playfulness	0.75
Presence-in-Absence	0.75
Opportunity for Social Support	0.75
<b>Costs</b>	<b>0.85</b>
Feeling Obligated	0.61
Unmet Expectations	0.70
Threat to Privacy	0.80

**Figure 9:** Inter-item reliability metrics for the ABCCT-Adult Questionnaire.

still within reasonable parameters to warrant their use. This reflects my design decision to create a questionnaire with fewer items, rather than focusing on the internal consistency of each individual scale. If internal consistency is of particular concern to the researcher, I recommend administering and reporting results along the entire Benefits and Costs dimensions (both of which achieve “good” internal consistency) rather than splitting the results into each specific scale. I also conducted a two-factor analysis of the responses (see Figure 8). This analysis shows that cost and benefit dimension are indeed orthogonal. The table also provides information about the contribution of each question to the overall dimensions.

### 6.5.2 Internal Consistency with Adults

I gathered inter-item reliability metrics by piloting the ABCCT-Adult questionnaire with 110 adults. The results of this analysis are presented in Figure 9. Overall, the Benefits and the Costs dimensions both achieve internal consistency classified as “good” [67]. All scales except the Feeling Obligated scale achieve Cronbach’s alphas within the “acceptable” to “good” range. It should be noted that a single item was dropped from the adult version of the ABCCT as a result of the internal consistency analysis. Dropping the statement “It is boring to use <M> with <P>” from the adult ABCCT led to the internal consistency of the Engagement & Playfulness scale rising from “poor” to “acceptable.” I hypothesize that this is due to the fact that this was the only negatively worded statement on the survey, causing some confusion for the participants. The Feeling Obligated scale achieves a Cronbach’s alpha in the “questionable” range. I posit that this is due to the small number of items in this scale

Question	Benefit	Cost
Communicating with X using the medium helps me feel closer to X.	0.796	
Communicating with X using the medium helps me feel more connected to X.	0.780	
Communicating with X using the medium helps me see how much X cares about me.	0.758	
I am excited about using the medium with X.	0.752	
Communicating with X using the medium helps me provide X with social support.	0.723	
X makes me feel special in our contact using the medium.	0.722	
I have fun with X while using the medium.	0.694	
Communicating with X using the medium helps me tell how X is feeling that day.	0.668	
Communicating with X when I am having a bad day helps me feel better.	0.654	
I feel that contact with me using the medium is engaging for X.	0.626	
I keep thinking back to something X shared using the medium.	0.597	
Communicating with X using the medium helps me let X know how I am feeling.	0.588	
Communicating with X using the medium helps me feel less worried.	0.545	
Communicating with me using the medium helps X be there for me.	0.410	
I worry that I am violating X's privacy during our contact using the medium.		0.760
I feel sad when X isn't around when I try to contact X using the medium.		0.691
I feel sad when X doesn't pay enough attention to me when we use the medium.		0.681
I worry that others may overhear or see something that X and I share using the medium.		0.673
I feel sad when X takes too long to respond when I try to contact X using the medium.		0.630
I worry that X might learn something using the medium that I want to keep secret.		0.626
I worry that X feels obligated to contact me using the medium.		0.611
I have to answer when X tries to contact me using the medium even if I don't want to.		0.581
I worry about my privacy while X and I were using the medium together.		0.572
I feel guilty if I don't answer a contact X makes using the medium.		0.556
I worry that I am not meeting X's expectations for our contact using the medium.		0.554
I have to talk to X using the medium even if I don't want to.		0.488

**Figure 10:** Factor analysis of the adult-version of ABCCT, showing the orthogonal nature of the costs and benefits dimensions, as well as identifying most significant questions to each dimension.

and argue that the alpha is still within reasonable parameters to warrant the scale's use. Again, this reflects my design decision to focus on creating a shorter questionnaire rather than focusing on the internal consistency of each individual scale. If internal consistency is of particular concern to the researcher, I recommend administering and reporting results along the entire Costs dimension (which achieves "good" internal consistency) rather than splitting the results into each specific scale. I also conducted a two-factor analysis of the responses (see Figure 10). This analysis shows that cost and benefit dimension are indeed orthogonal. The table also provides information about the contribution of each question to the overall dimension.

### **6.5.3 Test–Retest Reliability with Children and Adults**

All of the adult interview participants responded to the ABCCT retest request, allowing me to compare the measures for 27 ABCCT surveys total (13 participants responded about 2 communication media each, 1 participant responded about 1 medium). For adults, the correlation of the average reported benefits and costs of each communication technology on the two surveys given two weeks apart was 0.951 which is statistically significant ( $p < 0.001$ ). This shows that for adults, the ABCCT is a stable metric of a communication medium's emotional costs and benefits over a time period of two weeks.

Gathering an ABCCT retest measure from the children required more effort on the adult participants' parts (since the questionnaire needed to be administered verbally), so not all parents responded to the request to collect these measures from the child participants. I collected a total of 10 ABCCT retest surveys (5 participants responded about 2 communication technologies each). However, even with the reduced sample size, the correlation of the average reported benefits and costs of each communication technology on the two surveys given two weeks apart was 0.686 which is statistically significant ( $p = 0.001$ ). This shows that for children, the ABCCT is a stable metric of a communication medium's emotional costs and benefits over a time period of two weeks.

## **6.6 Validity Results**

To validate the ABCCT, I (1) compared the Benefits dimension with the results on the Social Connectedness questionnaire, (2) measured the relationship between the self-reported results on the ABCCT and the independently coded metrics gathered by coding participant interviews, and (3) demonstrated that the ABCCT is sensitive enough to discriminate between current technologies in expected ways.

### **6.6.1 Convergent Validity between the ABCCT and the SCQ**

I asked each of the 14 adult participants to fill out a Social Connectedness Questionnaire [176] to describe their sense of connection to their child. The Social Connectedness questionnaire is not validated for use with children so I could not collect convergent validity statistics comparing the ABCCT-Child and Social Connectedness Questionnaire.

It would stand to reason that participants who reported receiving higher benefits from each of the communication technologies they used to maintain contact with the child remotely on the ABCCT would also report a higher level of social connectedness with the same child on the Social Connectedness Questionnaire. Indeed, the correlation between the average benefits reported on all technologies used by each adult participant and the SC score was 0.652 for the 14 adult participants, which is statistically significant ( $p = 0.012$ ). This correlation confirms the expected relationship between the benefits dimension of the ABCCT and the construct of Social Connectedness. Unfortunately, no related construct currently exists to allow me to relate the costs dimension to an existing metric. To continue validating the ABCCT, I turned to interview analysis.

### **6.6.2 Convergent Validity between the ABCCT and Interview Coding**

It can be expected that interviewing a person about the costs and benefits of a communication technology should produce roughly the same findings as asking that person to respond to the ABCCT. I conducted hour-long semi-structured in-depth interviews with 14 parents and 14 children. One of my goals was getting participants to talk about the costs and benefits of the communication technologies they use. Several of the questions in the interview



Scale	Sample Interview Prompt	Sample Coded Phrase
Emotional Expressiveness	How can you tell how your son is feeling when you talk to him on the phone?	"I have to see them to really know. But sometimes it depends on what they are saying. If they get in trouble, yeah, usually."
Engagement & Playfulness	Tell me about a time that you and your mom had fun while using telephone together.	"Usually I act pretty goofy. Like we'll say something like an inside joke, and she'll laugh. And my brother, he'll say something weird. We don't what he be saying, but we just laugh."
Presence-in-Absence	How does exchanging MMS messages affect your sense of connection to your daughter?	"Well I have their pictures that I look at ... if I'm in the middle of wherever, I can just pop open my cell phone and look at the pictures."
Social Support	Tell me about a time that talking to your mom over videochat made you feel better when you were having a bad day.	"I guess as we start talking or we might joke around. Like I'm feeling blue and just kind of make a face and show her ... and you know, a lot of the negative stuff, kind of like dissipates."
Feeling Obligated	Can you give me an example of a situation where you didn't feel like talking to your mom on IM? What did you do?	"One time, my mom responded, and I didn't really want to, so I just ignored it."
Unmet Expectations	Can you give me an example of an expectation that you have of your daughter in terms of responding to you on the phone?	"Yes. I expect her to return my calls, and I expect her to definitely respond to my texts or phone calls, because otherwise I get very concerned."
Threat to Privacy	Can you give me an example of a situation where you worried that somebody else might hear your phone conversation with your mom?	"Yes, that's why I like going home [to make a call]. Like, some certain things, I don't mind saying that in front of my friends. But some stuff I like to keep in the house."

**Figure 11:** Sample interview prompts and sample coded phrases for each interview scale.

Scale	Cohen's Kappa
<b>Overall Agreement</b>	<b>0.612</b>
Emotional Expressiveness	0.63
Engagement & Playfulness	0.29
Presence-in-Absence	0.68
Opportunity for Social Support	0.50
Feeling Obligated	0.60
Unmet Expectations	0.71
Threat to Privacy	0.60

**Figure 12:** Agreement between the interview coding and the questionnaire responses for children.

were explicitly designed to draw out responses related to certain ABCCT scales in an open-ended manner. Figure 11 shows some of the questions that I asked in the interview to get insight into specific scales, as well as phrases from the interview that were coded as being relevant to that scale. However, I also coded phrases from the other parts of the interview that provided insight into specific costs and benefits of communication technologies. Since the interviewer did not pose the same questions as the survey and asked the participant to relate specific stories and experiences rather than data on frequency of particular events, not all participants addressed each scale in the interviews. If there was insufficient evidence in the interview to code a participant as “low,” “medium,” or “high” on a specific scale, that scale was dropped from the analysis (7.4% of scale–medium pairings for adults, 16.6% of scale–medium pairing for children).

#### *6.6.2.1 ABCCT vs. Interview Coding with Children*

Overall agreement Cohen’s Kappa was 0.612 (over 146 codes), which is statistically significant ( $p < 0.001$ ). Figure 12 shows the Cohen’s Kappa for each scale on the survey. The “Engagement & Playfulness” scale stands out as having the lowest level of agreement. The interview coding almost always predicted a lower response than the one that appeared on the survey. The interview asked children to recall a time that they had fun with their parent while using a certain communication technology together. Many of the children could not recall a single instance of “having fun.” Yet, on the survey the same children reported that talking to their parent was “never” boring and “sometimes” or “frequently” fun. There could be two possible reasons for this observation. First, it’s possible that children are

Scale	Cohen's Kappa
<b>Overall Agreement</b>	<b>0.793</b>
Emotional Expressiveness	0.85
Engagement & Playfulness	0.78
Presence-in-Absence	0.76
Opportunity for Social Support	0.62
Feeling Obligated	0.71
Unmet Expectations	0.65
Threat to Privacy	0.84

**Figure 13:** Agreement between the interview coding and the questionnaire responses for adults.

simply not very good at recalling specific past examples, but may in fact have a better gestalt impression of their engagement with their parents. Alternatively, it is possible that children experience greater demand characteristics in the survey—a child may not want to say that talking with their parent was boring for fear of hurting their parents’ feelings. In this situation, it is difficult to know whether the interview code or the survey response is closer to the ground truth. With children, it seems that one may have to triangulate evidence from multiple sources in order to get an accurate understanding of their engagement. However, it seems that on the other scales, the interview and the ABCCT responses corresponded significantly for each participant—evidence that the ABCCT-Child measures what it intends to measure.

#### 6.6.2.2 *ABCCT vs. Interview Coding with Adults*

Overall agreement Cohen’s Kappa was 0.793 (over 175 codes), which is statistically significant ( $p < 0.001$ ). Figure 13 shows the Cohen’s Kappa for each scale on the survey. The adult version of the ABCCT showed significant agreement on all scales between the experiences related in the interview and the responses given on the written ABCCT. These results provide strong evidence that the ABCCT-Adult measures the same construct as gleaned from the independently coded interviews.

### 6.6.3 Discriminating between Different Communication Technologies

While convergent validity metrics reported above do suggest that the ABCCT measures affective benefits and costs of communication technologies, to those who seek to use the

Communication Technology	# of Surveys
Telephone	43
Videoconferencing	20
IM	19
Texting	16
Email	10
Photo Sharing Service	1
Word-Based Game Phone App	1

**Figure 14:** Number of online ABCCT surveys addressing each communication technology in the adult pilot of the survey.

ABCCT questionnaire to understand and evaluate communication systems it may be more important to know that the ABCCT is actually sensitive enough to be able to discriminate between two different communication technologies. I used the data from the ABCCT administered online to 110 adults to address this concern. Unfortunately, I could not conduct a similar analysis for ABCCT-Child as the vast majority (82%) of the children’s responses in the Preston trial addressed the telephone. There were no more than 5 responses addressing any other technology, so I could not conduct a meaningful quantitative comparison.

However, since the adult pilot gathered a number of responses for a fairly diverse set of communication technologies (see Figure 14), I could conduct three relevant comparisons. First, I decided to compare two synchronous and two asynchronous communication technologies most frequently described in the online surveys. I used a two-tailed Mann-Whitney Test to compare telephone versus videoconferencing, IM versus texting, and texting versus videoconferencing on each of the 7 ABCCT scales. Figure 15 shows the results of these comparisons. As could be expected, videoconferencing scored significantly higher on the Engagement & Playfulness and Presence-in-Absence scales. This is consistent with previous qualitative findings in the field (e.g., [6, 12]). Participants also felt more unwanted obligations with the telephone. Perhaps a bit surprisingly, I saw no statistically significant difference between telephone and videoconferencing on Emotional Expressiveness and Threat to Privacy scales, though both did show small differences in the expected directions (on average, videoconferencing supported emotional expressiveness more but introduced more threats to privacy). This is perhaps due to high individual variability and the fact that the comparisons were made between (rather than within) participants.

Telephone vs. Videoconferencing			
Scale	Phone Avg.	Video Avg.	Mann-Whitney
Emotional Expressiveness	3.86	4.02	not significant
Engagement & Playfulness	3.42	3.84	p = 0.044
Presence-in-Absence	3.84	4.30	p = 0.027
Social Support	3.57	3.68	not significant
Feeling Obligated	2.22	1.79	p = 0.049
Unmet Expectations	2.36	2.14	not significant
Threat to Privacy	1.81	2.04	not significant
IM vs. Texting			
Scale	IM Avg.	Text Avg.	Mann-Whitney
Emotional Expressiveness	3.67	3.15	p = 0.023
Engagement & Playfulness	3.54	3.14	p = 0.047
Presence-in-Absence	3.51	3.17	not significant
Social Support	3.54	3.50	not significant
Feeling Obligated	2.32	2.03	non-sig. trend (p = 0.160)
Unmet Expectations	2.51	2.22	not significant
Threat to Privacy	1.89	1.39	p = 0.013
Videoconferencing vs. Texting			
Scale	Video Avg.	Text Avg.	Mann-Whitney
Emotional Expressiveness	4.02	3.15	p < 0.001
Engagement & Playfulness	3.84	3.14	p = 0.004
Presence-in-Absence	4.30	3.17	p < 0.001
Social Support	3.68	3.50	not significant
Feeling Obligated	1.79	2.03	non-sig. trend (p = 0.170)
Unmet Expectations	2.14	2.22	not significant
Threat to Privacy	2.04	1.39	p = 0.038

**Figure 15:** Comparing different communication technologies using the ABCCT, in the adult pilot deployment. All comparisons were done using 2-tailed Mann-Whitney tests.

Comparing IM and Texting showed that IM scored higher on measures of Emotional Expressiveness and Engagement & Playfulness. My interview data suggests that this might be due to IM's support for images, emoticons, and ability to link to other media (e.g., YouTube clip) [187]. There is some trend (through not statistically-significant) for IM introducing more unwanted obligations, which is consistent with Grinter et al.'s qualitative work examining IM and SMS [71]. Also as expected, IM introduced significantly more threats to privacy than texting, due to the fact that IM conversations can easily be saved and passed along to others. Lastly, I compared videoconferencing and texting, because these two media have been previously compared on social presence measures in the lab [76]. These two media are quite different and I expected to see differences on a number of scales. Indeed, I found that videoconferencing was significantly better at supporting emotional expression, engagement & playfulness, and presence-in-absence. Also, as can be expected, videoconferencing introduces significantly greater concerns over privacy. However, texting introduced more obligations to communicate than videoconferencing, which is consistent with interview findings that users are often expected to answer their texts in a timely manner [187]. It is encouraging to see that ABCCT was able to highlight some statistically significant differences between communication technologies even with a relatively low number of responses and data collected between (rather than within) participants.

## ***6.7 Discussion***

I provide guidelines for the use of the ABCCT questionnaire, discuss its limitations, and provide directions for future work.

### **6.7.1 Guidelines for ABCCT Questionnaire Use**

The ABCCT can be administered to adults on paper or online. My pilot deployment with 110 adults was completed online with minimal instruction for participants. Most participants did not have trouble with the survey, but it should be noted that 2 participants filled out the survey for multiple media rather than focusing on a single technology. It is important to convey to the participant that the questionnaire must be filled out for a single technology and a single personal relationship. Whenever possible, the researcher should

aid the participant by filling in the “person” and “medium” fields with appropriate values ahead of time or programmatically at the time of taking the survey.

In administering the ABCCT-Child Questionnaire, I recommend following Borgers & Hox’s guidelines [22]: the questionnaire should be clearly explained or include a clear instruction page, the questions should refer to the opinions and behaviors of a recent time period (e.g., past week), and all options on the survey should be labeled (“Never,” “Rarely,” “Sometimes,” “Usually,” and “Always”). While this survey has only been validated for children over 8, it may be usable with younger children by reducing the number of options (e.g., “Never,” “Sometimes,” “Always”). In all cases, I recommend that the survey be administered as a structured interview to children (i.e., read out loud to the child) whenever possible, as this helps ameliorate individual differences in reading level and comprehension. Additionally, this allows the researcher to make the substitution for the “person” and “medium” being investigated, rather than placing the burden of this cognitive task on the child.

The main value of the ABCCT is in allowing the investigator to make comparisons between different technologies. Here are several potential scenarios for appropriate use of the ABCCT:

- Two versions of a novel communication technology (with and without an experimental feature) are deployed one-after-another within participants (counterbalanced for order) in a series of homes. Each participant fills out the ABCCT for each technology after the deployment. A pairwise comparison is used to point out how the experimental feature affected the benefits and costs of the novel technology for the individuals in the study.
- A novel technology is deployed to replace the use of a particular current technology (e.g., better IM client). Before the study, the participant is asked to fill out the ABCCT for the current technology. The new technology is deployed. After the deployments, the participant is asked to fill out the ABCCT for the novel system. A pairwise comparison is used to point out how the novel system differs from the status

quo system.

- A novel technology that is meant to supplement the currently used communication systems is deployed in the field. Before the study, the participants fill out ABCCT questionnaires for each of the communication media they currently use. After the deployment, participants fill out the ABCCT for the novel system and again for each of the communication media they currently use. An analysis of these results can show whether the new system filled a need different from the other systems, whether previous systems were now perceived differently because of the introduction of the novel technology, and how the novel system compares to the previously used system on each of the ABCCT dimensions.
- An investigator wants to conduct a meta-analysis showing that adding a particular feature to a communication system has a predicted effect on a specific ABCCT scale. He or she gathers all papers that investigated relevant systems with this feature and all papers that investigated relevant systems without this feature. Assuming these papers presented ABCCT scores (or made these metrics available by request), the investigator can use standard meta-analysis techniques to draw comparisons and conclusions.

Since there is a great deal of individual difference in how communication technologies are perceived and used, the greatest statistical power can be gained by making comparisons within-participants, however large-N between participant studies are also appropriate.

I caution the investigator against making between-study comparisons when only a small number of other studies are available on a particular issue of interest. Particularly, drawing favorable or unfavorable comparisons against a technology in one previous investigation is more likely to be misleading than informative. Brown et al. point out the incredible difficulties in attempting to generalize from single-case field deployments, as even small variations in participants and methods can lead to drastically different interpretations of the same technology [24]. However, as similar technologies are deployed in a variety of contexts, there may be a large enough sample to compensate for this variability and allow for between-study comparisons.



### 6.7.2 Limitations

Researchers should understand the inherent limitations of the ABCCT questionnaire before using it. Most importantly, I want to convey that this questionnaire should not be used as the only evaluation metric for a novel communication technology.

First of all, the emotional aspects of communication are inherently nuanced. While the ABCCT provides a good way to collect data to compare systems and synthesize findings across investigations, qualitative methods are still the best way of understanding the inherent differences and contextual factors that play into the adoption and use of a novel system for communication. Triangulating data from rich qualitative metrics and the structured data from the ABCCT would lead to more valuable results than using either method alone.

Secondly, the adoption and use of communication technologies is influenced not just by emotional factors but also by pragmatic time-related and effort-related factors. For example, videoconferencing is frequently not used by families because of the complex work required to set up a session [6] and because of the undivided attention demanded by this medium [187]. On the other hand, other communication media that have very low time and effort costs to compose and send a message may be compelling even if they do not provide a rich channel for communication (e.g., [92]). Other communication media lower the cognitive costs for planning and composing an interaction by providing guidance to the user. For example, in several communication systems created by Nokia Research, an Elmo character guides adult participants in adopting a communication style that is engaging to young children and provides them with ideas for conversation topics [142, 144, 145]. However, there are also benefits of technologies that require high personal effort. For example, Tee et al. reported that communications that required personal effort and thought were much more valued by the recipients [171]. Measuring the costs of initiating contact, the costs of composing or maintaining the contact, the time costs of the contact, and the opportunity provided for demonstrating personal effort are all meaningful metrics for communication technologies but outside of the scope of the ABCCT questionnaire.

Lastly, the ABCCT questionnaire has the same limitations as other questionnaire methods appropriate for field evaluations. The participants fill out the ABCCT some time after

events of interests occur, so participants may forget important issues or have trouble estimating the frequency of particular events. Participants may be biased to present themselves in a positive light to the investigator and therefore choose responses that may not accurately reflect their experiences with the technology. Additionally, participants may respond to the demand characteristics of the investigator, especially when the expected results easy to deduce (e.g., within-subjects design where the experimental system is obvious). This may be especially true of children, who often worry about providing the adult with “the right answer.” Triangulating the results from multiple methods and multiple sources of data can mitigate these shortcomings. Additionally, taking care to equalize power between the child and the researcher using classic participatory design methods can address some inequalities that exacerbate demand characteristics with children (e.g., [116]).

### **6.7.3 Future Directions**

There are a number of future directions that emerge from this work: (1) designing a methodology for measuring the “pragmatic” costs and benefits of a communication technology, (2) using the ABCCT in the field and iterating on the design when necessary, (3) creating alternative versions of the ABCCT that may be useful for experience sampling methodologies.

The ABCCT does not provide a complete picture of a participant’s experience with a communication technology. Understanding the pragmatic costs and benefits of communication technologies, such as the time and effort expended during use, may help complete this picture. It may be possible to gather some of this data using survey methodologies, but it may be impractical due to the difficulty that users may have recalling the exact amount of time spent on a particular interaction. Logging methodologies may be most valuable in this domain, perhaps in combination with some appropriate self-response data (for example, getting a participant to reflect on specific log data in an interview).

One of the potential benefits of the ABCCT is in supporting synthesis and comparison across technologies in multiple studies. However, in order for this to be possible, investigators must include the ABCCT in their methods and report (or make available upon request) the results of these deployments. As the ABCCT is utilized in diverse contexts, it is quite

likely that shortcomings will emerge that will need to be addressed in future iterations. As such, I greatly encourage any investigators who chose to use the ABCCT to share their experiences with the authors of this instrument. I also encourage investigators to modify the ABCCT to suit the needs of a particular research project, though with the caution that such modification may need to be validated before use.

One of the limitations of the ABCCT is that it asks participants to reflect upon past experiences, potentially leading to recall mistakes. Ideally, the survey could be adopted to pose appropriate questions to the participants immediately after an event of interest has occurred. For example, immediately after receiving a message from a loved one or terminating a synchronous communication session, the participant can be asked to answer 2–3 questions about their experience. While it would be impractical to administer the entire ABCCT after each session with the technology, a system may be designed to ask a random subset of relevant questions. Collecting such responses over the course of a long deployment may contribute to an understanding of the system with less recall bias. Designing such a method would not only involve rewording the questions to be relevant in the moment, but also designing the system that would provide the participant with the questions at the appropriate time. This may be particularly challenging when trying to gather baseline information about common technologies such as the phone.

## **6.8 Conclusion**

This work presents the design and initial validation of a questionnaire instrument for measuring the Affective Benefits and Costs of Communication Technologies (ABCCT). I discuss the pilots of this survey with 45 children and 110 adults, leading to the preliminary conclusion that the ABCCT has acceptable inter-item reliability. I discuss the results of interviews with 14 children and 14 adults, which help confirm that the ABCCT measures the same constructs that may emerge through an interview investigation. I show that the ABCCT has high test–retest reliability and convergent validity with the Social Connectedness metric. Finally, I demonstrate that the ABCCT is sensitive enough to discriminate between

different communication technologies and results in findings that are consistent with previous work in the field. Though the ABCCT is not without its limitations, it provides the first steps towards a reliable and valid way to compare communication technologies in field deployments.

## CHAPTER VII

### DESIGN AND INITIAL PROOF-OF-CONCEPT FOR THE SHARETABLE SYSTEM

My formative investigations provided me with a better understanding of the problem space of supporting remote parent–child interaction. In this chapter, I describe the process I took in exploring the solution space, as well as a number of design ideas that I considered early in the process. Through iterative design, critique, and feedback from potential users, I decided to pursue the ShareTable concept—a system that combines easy-to-initiate videochat with a shared tabletop task space. I describe the design of this system, the initial prototype implementation, and its initial evaluation in the lab with seven parent–child pairs.

#### *7.1 Design Explorations of the Problem Space*

I conducted several rounds of ideation and idea selection around the problem of supporting long-distance parenting. I describe the initial round of ideation and idea selection and then focus on two follow-up rounds of design—of the eMutts system and of the ShareTable. A selection of sketches from the design process is available in Appendix B.

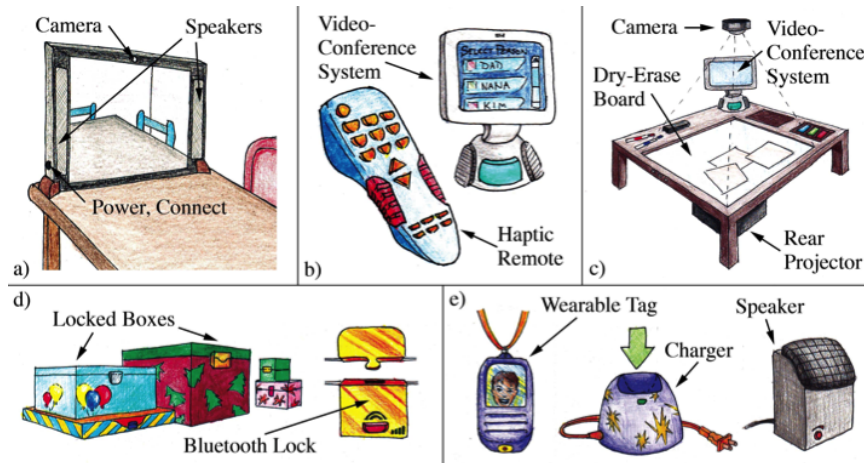
##### **7.1.1 Initial Ideation & Idea Selection**

First, five HCI experts informed by previous work in the space brainstormed ideas for parent–child communication, focusing mostly on fluency of ideas.<sup>1</sup> I applied affinity diagramming to combine key ideas and select five most interesting design alternatives to sketch:

1. The CoMeal system (see Figure 16a) lets the distributed families have meals together and to discuss everyday issues at the dinner table. A large videoconferencing screen, mounted on the table head, shows the scene of the distant dining area. CoMeal allows

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<sup>1</sup>Stephen Cuzzort, Brian Di Rito, Hendrik Mueller, and Hina Shah contributed to the initial design generation



**Figure 16:** Conceptual designs from the first round of ideation: a) CoMeal, b) TV Buddy, c) ShareTable, d) RemotePresent, and e) ChildAware.

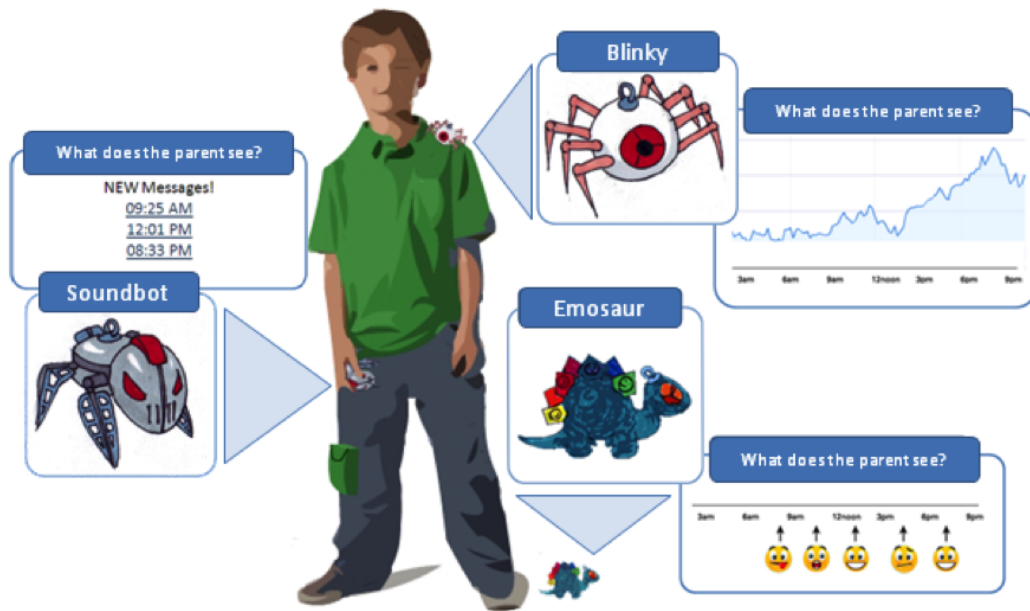
the distant parent and the child to converse over dining, facilitating casual breakfast and dinner conversations.

2. The TV Buddy system (see Figure 16b) lets the non-residential parent and the child simultaneously watch TV. The system augments a TV with a touch-screen videoconferencing device and a haptic-feedback remote. The remote assures the synchronization of the channels on both TVs. When either person intends to switch the channel, the other person's remote starts to vibrate; squeezing the remotes may determine who takes control. The video-conferencing system, activated simultaneously, may facilitate the transition from watching TV to casual interaction.
3. The ShareTable system (see Figure 16c) supports asynchronous as well as synchronous activities that require access to shared physical artifacts such as worksheets, board games, and pictures. The system may consist of a table, a projector, a camera, and a videoconferencing device. The two tables remain synchronized, allowing both users to view items placed and manipulated on each other's table.
4. The RemotePresent system (see Figure 16d) lets the distant parent reward the child with a present. The parent may give a locked box to the child while visiting or send it through the mail. The child cannot open it until the parent sends a special signal through his or her cell phone that unlocks the box. The phone may then call the child

to let the parent be virtually present as the gift is opened.

5. The ChildAware system (see Figure 16e) lets the parent stay aware of the child's daily activities and share context-sensitive prerecorded messages. The child may wear a tag on his or her lanyard, which triggers messages depending on the proximity to detection devices placed in key locations like rooms in the home, grandparents' house, and the family car. The parent may also record custom messages to be played for the child when a certain event occurs.

I surveyed eleven parents from three leading long-distance parenting forums, asking them to rank and provide qualitative feedback on my designs. TV Buddy was the least popular of the five ideas; parents thought that watching TV did not facilitate parent-child communication. ChildAware earned only slightly higher ratings than the TV Buddy. Parents questioned whether the child would agree to be monitored with a tag and whether recorded messages would really lead to a feeling of greater intimacy with the child. However, three parents ranked this idea highly and saw potential for it, provided it could detect and share the right information. RemotePresent received considerably more positive responses. It conforms to the current practice of parents' hiding presents while visiting and revealing them to the child some time later. CoMeal was ranked favorably by parents mainly due to its potential to introduce opportunities for spending quality time together. The parent may keep the system turned on at all times to use it as a window into the child's everyday life. The ShareTable received the most favorable feedback from the surveyed parents; eight out of the eleven parents ranked it as the best or second best idea. Parents suggested a wide variety of alternative uses of the ShareTable, from collaborative drawing to sharing pets' antics. Moreover, parents preferred this system because of its ability to support casual, spontaneous interaction and due to its flexibility of use. I decided to pursue ChildAware (later reconceptualized as eMutts) and the ShareTable as the two most interesting and promising ideas.



**Figure 17:** Examples of three eMutts and the information they share with the parent.

### 7.1.2 Design Concept: eMutts

I chose to continue exploring the idea behind ChildAware, because my interviews with divorced families (described in a previous chapter) yielded several challenges that could be addressed with a child-appropriate awareness system.<sup>2</sup> Parents reported seeding conversation and staying aware of the child's activities as two major challenges to maintaining contact. An awareness system could address this by providing frequent information about the child's surroundings and explicit messages from the child. Children found it challenging to share thoughts spontaneously or to find a private space for communication with current technologies. Mobile sensors and input toys can provide an unobtrusive, on-the-spot way to share with the remote parent. However, the initial feedback round showed that parents were unsure about the ChildAware idea as initially presented. To reconceptualize ChildAware, I conducted a second round of brainstorming to identify potential data that could be sensed

<sup>2</sup>This work was originally published in the *Mobile Technology for Children* book [190]. Claudia Winegarten aided with critique and conceptualization of this design.



and transmitted to the parent; I also conducted a review of successful mobile devices currently available to children. Selected ideas were embodied as sketches (see Appendix B) and presented to 3 parents for comments. From parent feedback, I determined that it may be beneficial to provide a large variety of sensors and toys and allow the child and parent to negotiate which would be active at any point in time. The eMutts system seeks to address the challenges that parents face in seeding conversation and staying aware of their child's state and activities while apart and encourage spontaneous self-disclosure from children, while still allowing the child to maintain a reasonable level of privacy.

The eMutts system consists of a series of keychain-sized toys, each containing a sensor or a capture device. A pedometer sensor, for example, tracks the number of steps the child has walked at different times of the day, while an ambient noise sensor may show how loud the child's surroundings were throughout the day. Capture devices include toys that allow the child to record audio or image messages, a stress-ball creature that records how hard it is squeezed, or a toy with buttons corresponding to different moods. The child may select one or two of these toys to carry with them during the day. At the end of the day, the toys dock to upload their data to the child's computer. The parent can use a web-based interface to see information about the child's activities during the day and any messages or images the child may have recorded. The parent can then use this information as a starting point in his or her conversations with the child. Figure 17 shows some example eMutt toys and data shared (for additional toy sketches, see Appendix B).

An online game is used to motivate children to actively wear and interact with the mobile device toys. Each sensor is represented as a different pet with preferences and a personality. For example, the pet associated with the image-capture toy get happier if the child wears it and even happier if the child takes pictures to share with the parent. Children are given points in the online game for keeping their collection of pets happy, while parents can contribute to the points by viewing and responding to the shared information. By providing playful motivation for children to stay in touch and tools for parents to stay aware of their children's everyday activities, I hope to lay the groundwork for improving parent-child communication and intimacy in distributed families.

The eMutts system seeks to empower the child to manage his or her privacy by selecting which sensors to carry or not to carry on a given day. As a community, we know relatively little about the specifics of how parents and young children manage privacy—eMutts may provide an interesting opportunity to explore this issue in more detail by serving as a technology probe. The challenge lies in balancing the conflicting needs and desires of the parties involved in the interaction and allowing privacy to be negotiated in a dynamic fashion. The information shared by eMutts is relatively ambiguous, requiring interpretation and further probing on the part of the parent. While there is evidence that family members are skilled at understanding another’s context from ambiguous data [18], eMutts can provide an opportunity to better understand how parents may combine and interpret multiple sources of information. The associated challenge is finding ways to visualize and present this data in a way that best supports interpretation.

The last challenge is that of balancing the external motivation provided for children through game mechanics with the desire to foster internal motivation to communicate. Dalsgaard et al. have suggested that children are generally less motivated to self-disclose than their parents desire [42]. While eMutts may structure and scaffold self-disclosure by seeking to fill this gap in motivation, eventually the goal is for the child to realize the inherent value of sharing information with their parent and be equipped to do so independently. Designing eMutts was an effort to respond to the current challenges of parents and children, however it also represents a type of asynchronous awareness system that has already been the focus of many HCI investigations (see my review in chapter 3). In order to focus on the less explored area of synchronous communication, I set eMutts aside for the purpose of this thesis.

### **7.1.3 Design Concept: ShareTable**

The process of arriving at the current design of the ShareTable involved many other explorations. Some of these may potentially become other parent–child communication projects, but the remainder of this thesis focuses on the ShareTable system. ShareTable was one of the five ideas selected in the first idea selection phase, based on feedback from parents in

long-distance parenting forums. The initial interest in the idea drove me to formalize the design requirements for this system and create a proof-of-concept prototype.

The four most important requirements for a synchronous communication system for parents and children that emerged from the analysis of my interviews with divorced families and my review of related literature were as follows:

**Include Visual Channels for Communication** The most common theme reported by both parents and children in my study was dissatisfaction with audio-only communication. During the middle childhood, children are still developing the conversational competencies to interpret irony, humor, and fantasy [165]. Providing multiple channels and modalities for communication, particularly video, affords additional cues for the child.

**Function without a Collocated Adult's Help** Videoconferencing was not used regularly by the families I interviewed, because the system is complex enough to require a collocated adult's involvement to arrange a chat session. Additionally, some parents saw it necessary to supervise videoconferencing, since the child could potentially contact or be contacted by a stranger. My goal is designing a dedicated communication system with a minimal control interface that reduces the need for a co-located adult to assist the child with setting up and maintaining the connection.

**Support a Wide Variety of Play Activities** Keeping the child engaged and seeding conversation were two major challenges reported by parents. I seek to support engagement by leveraging fun activities that the parent and child are already used to doing together. I emphasize the system's ability to support a variety of activities, rather than incorporating interfaces for specific games or requiring specific accessories.

**Provide Opportunities for Care Activities** There is strong evidence that instrumental involvement of both parents correlates with positive outcomes for children [94]. Many care activities require physical presence; however, there is a clear opportunity for remote instrumental care in providing homework assistance. The challenge to us as designers is to afford transitions between the physical artifacts of homework that

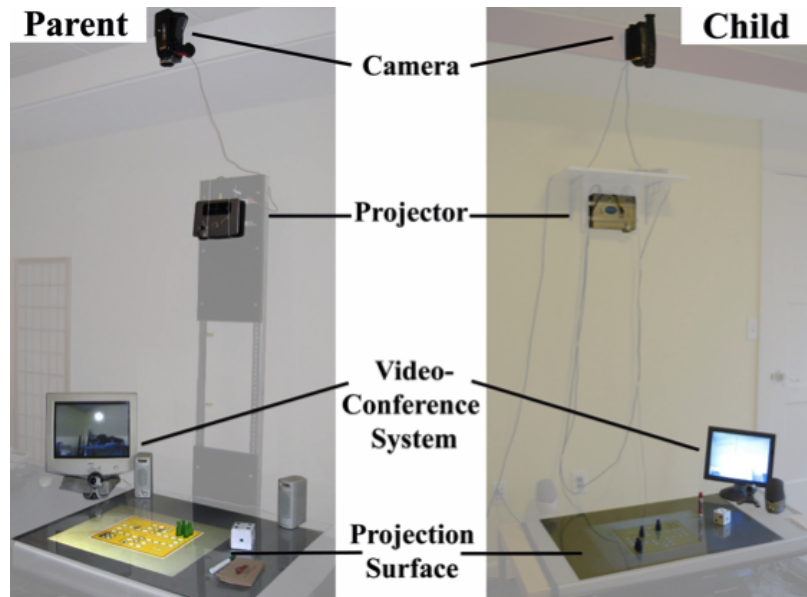
the child possesses (e.g., textbook, worksheet) and digital versions of these artifacts which the parent can view and annotate.

In conceiving an early implementation of this system, I drew my inspiration from the significant body of research work that addresses supporting remote communication in the office, particularly the concept of a media space. A media space is an audio and video connection between two distributed locations for the purpose of maintaining social and work connections. Media spaces have been used since the mid-80s to synchronously connect workplaces and to support collaborations between geographically-distributed offices [19]. The audio–video connection can be supplemented with a shared workspace to support collaboration over documents, data, etc. There are a number of such media spaces which share implementation aspects with the ShareTable, including TeamWorkStation [86] and Video-draw [169]. Like the ShareTable, these systems create a shared workspace through video; however, my system is different in that it overlays physical artifacts from both surfaces, therefore requiring top-down projection (I discuss this in more detail in the next section, as I describe the implementation challenges). The PlayTogether [185] system is most similar to the ShareTable in its use of top-down projection and a light-weight approach to removing visual echo (I describe this challenge in the next section). PlayTogether uses an IR emitter and filter in order to remove visual echo, but this solution removes color from the video. Because perceiving color is important for a number of childhood activities, I implemented an alternative light-weight approach that preserved this characteristic. My work expands on the PlayTogether project by applying the technology to a new domain and providing empirical insight into how such a system may be used. In contrast to the systems above, my development of the ShareTable was driven by the unique needs of parents and children.

In its most basic form, the ShareTable consist of a standard videoconferencing setup to support a person-space view and a tabletop that provides a shared task-space view (see diagram in Appendix C). The overhead camera captures activity over the surface of the ShareTable and sends it as a direct video stream to be projected on the surface of the partner’s table. This allows the ShareTable system to support separated parents and children in engaging with each other through shared tasks rather than only conversation.

Because the system transmits direct video, the ShareTable is not bound to a specific activity and it does not require specialized books, games, or toys. It supports a variety of play activities because the parent and child can use familiar toys that they may already have around the house rather than specialized accessories. This is particularly important to supporting helping with homework, as textbook and worksheets are usually provided by the school. To support functioning without a collocated adult’s help, the ShareTable system provides a paired connection between the two households triggered by a physical interaction with the system (opening the cabinet doors). This makes it possible for a young child to initiate the interaction without remembering user names, having to log in, or having to remember to end the call when done.

The ShareTable is influenced by the paradigm of embodied interaction. Dourish defines embodied interaction as “the creation, manipulation, and sharing of meaning through engaged interaction with artifacts” [48]. Systems that support embodied interaction leverage our inherent abilities to function in a physical world and organize our activity in concert with others according to social conventions. In the case of mediating parent–child communication, an embodied approach is one that allows both parties to leverage their experience of interacting with each other in-person to continue building shared meaning while apart. I aspired to this paradigm in developing the ShareTable prototype for supporting parent–child communication. Three aspects of the ShareTable design address embodied interaction: (1) interaction through physical artifacts, (2) emphasis on the place where communication occurs, and (3) a physical metaphor for controlling the system. First, the ShareTable invites the user to share the same physical artifacts they use during in-person interaction. I leverage familiar aspects of interactions like putting pieces on a game board, drawing with a marker, or seeing the other person by looking across the table. There are no modifications required to prepare an artifact for use with the system—anything put on the table will be visible to the other person. The ShareTable does not prevent a user from blocking the view of one item with another, does not enforce rules or turn-taking in games, and does not automatically clear any marks off the table surface at the onset of a new activity. Rather, it relies on cooperation between the two parties and social conventions to moderate these



**Figure 18:** The lab setup of the initial ShareTable evaluation with the physical components of the system highlighted.

aspects of the interaction. Secondly, I emphasize the importance of the communication setting by implementing the ShareTable as a piece of furniture with an established location in the home. In doing so, I capitalize on the importance of place in mediating interaction in the home and structuring family routines around technology [38]. The ShareTable as a rooted object presents certain boundaries as to where and by whom it might be used. Each family can negotiate these boundaries through the same mechanisms they used to decide the location of a TV, computer, couch, etc. Lastly, I looked to create embodied ways of controlling the system state. Opening the doors of the ShareTable cabinet answers or places a call to the paired table; closing the doors ends a call. I leverage a physical metaphor to support the child in being able to independently initiate contact and to make it immediately apparent to the users whether the system is transmitting or not.

I chose to pursue the ShareTable system in my thesis both because it had the greatest potential for positive impact for families and because of the contributions that I could make through its design, implementation, and deployment.

## 7.2 *ShareTable Lab Prototype Overview*

Before investing the time and resources to create a robust prototype for a field deployment, I created and tested an early functional prototype to serve as a proof-of-concept for the ShareTable design.<sup>3</sup> The initial prototype was set up in the “home office” and “child’s room” of the AwareHome [99]. This allowed me to test the system in a controlled setting that was more friendly and familiar than a regular lab space. The ShareTable system consists of two identical table setups (see Figure 18). Each shared workspace consists of an overhead camera that records any activity over the surface and a projector that displays this video on the paired table in the other room. The video from each camera is aligned precisely with the projection, so that artifacts placed on one table appear projected in the same location on the other table. The tabletop is coupled with a videoconferencing system (i.e., monitor, webcam, speakers, and microphone) that let the users see and hear each other “face-to-face.” As in other videoconferencing systems, each user also sees a smaller video window showing how they appear to the other person. The basic idea behind the ShareTable is simple, but multiple design and implementation challenges were addressed in developing this functioning prototype:

**Layering Physical Artifacts.** In order to support layering physical artifacts in a realistic way, I implemented the ShareTable using top-down projection. For example, if the parent places a physical token on a projected game board, top-down projection allows the projected token to appear on top of the child’s physical board rather than projected unseen on the board’s bottom. Similarly, if a parent writes a comment on top of a projected worksheet, top-down projection allows this annotation to be displayed on top of the physical worksheet.

**Removing Visual Echo.** Visual feedback or “echo” is a major concern in camera-projector systems [119]. Unmodified, the camera records an image of the projected artifact and sends it back to the originating surface. If the physical artifact is moved, an echo of its

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<sup>3</sup>This work was originally published in at IDC 2009 [189]. Stephen Cuzzort, Hendrik Muller, Hina Shah, and Brian Di Rito contributed to creating the prototype and running the lab study.

projection remains on the surface. If projected images are re-projected without any intervention, the resulting image keeps getting brighter and less clear. Without some way to filter projected artifacts from real ones, the ShareTable would be unusable due to this feedback effect. I wanted a light-weight way to eliminate visual feedback, so I used linear polarizing lenses to filter out the projected artifacts from the physical ones. Light that passes through the lens becomes polarized and cannot be seen through a lens with the opposite polarity. Thus, by attaching lenses with perpendicular polarization to the camera and projector, I prevent artifacts from being re-projected. In order to preserve the polarization of the light once it strikes the table surface, I use a non-depolarizing silver lenticular projection screen as the surface backdrop.

**Minimizing Complexity.** In designing for families, it is important to minimize complexity and cost. I sought to do so by leveraging existing systems and off-the-shelf components. The face-to-face audio-visual feed uses a computer with a standard videoconferencing software (Skype) and hardware (a webcam and a microphone). Any camera and projector could be modified for use with a shared surface just by adding linear polarizing filters. Any tabletop could become a ShareTable through the addition of the non-depolarizing projection surface. Writing or drawing on the table surface is accomplished through dry-erase markers rather than with computationally-intensive computer vision techniques. Most importantly, the ShareTable does not require any specifically designed accessories: most board games, books, and school worksheets are usable with it.

Though this prototype was functional, there were more technical challenges to be resolved before such a system could be deployed for long-term use in an actual household. To inform the design directions and priorities for my continued work with this system, I performed an exploratory evaluation to see how the ShareTable functioned when used by parents and children in a controlled setting.



### **7.3   *Lab-Based Evaluation***

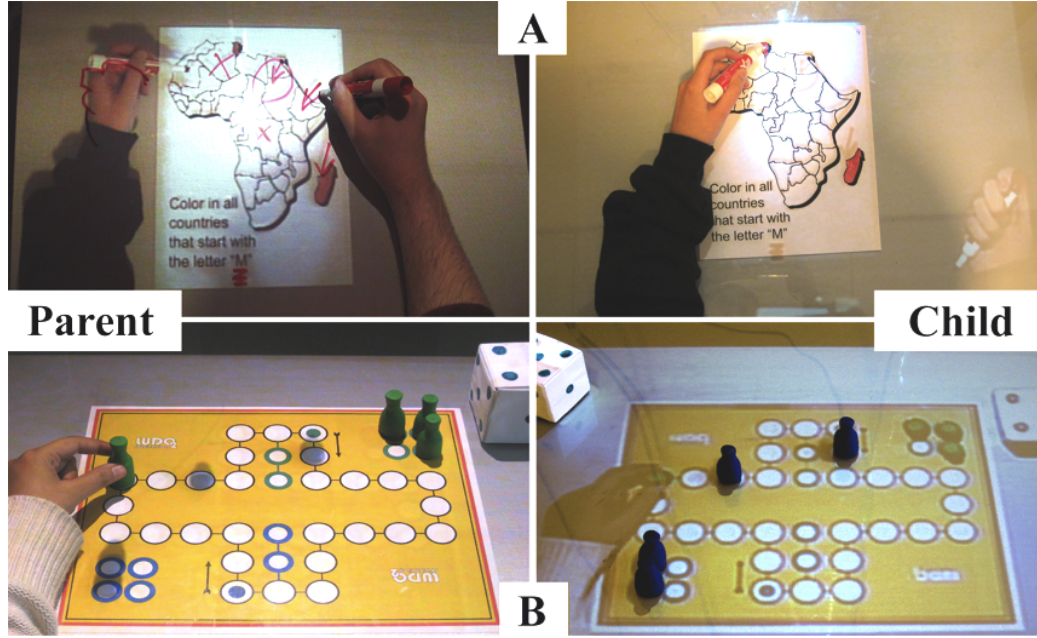
I present an exploratory lab-based evaluation of the ShareTable with seven parent–child pairs aimed at investigating three questions. First, I explore whether the shared workspace benefits the interaction. To do so, I compare how parent–child pairs complete a homework task using the ShareTable system versus using just plain videoconferencing. Second, I was unsure whether young children would be able to understand and manage the unfamiliar interweaving of physical and virtual spaces created by the ShareTable. To investigate this, I observed how parents and children manage turn-taking and access to physical artifacts while playing a board game remotely. Finally, I was interested in finding out how the participants would spend unstructured time with the system to see which attempted activities are unsupported by the ShareTable. I conclude with a discussion of how the results of my evaluation informed potential changes to the design of the prototype.

#### **7.3.1   *Methods***

In this section, I describe the participants, setting, and procedure of the lab-based deployment.

##### *7.3.1.1   Participants & Setting*

Seven parent–child pairs participated in the study. The set of parents, four males and three females, varied in age from 30 to 44 (average 37.3, median 38). Their occupations ranged from attorney to professor to student, but all had a high degree of education. The children, three females and four males, were between 7 and 10 years old (average 8.4, median 9). Overall, three father-daughter, one father-son, and three mother-son pairs participated. I recruited these participants through word-of-mouth and fliers posted around campus. I advertised that I was looking for individuals interested in technology for families who spend significant time apart. One of the seven parent–child pairs represented a divorced family. The other six pairs represented families in which one or both of the parents were often away from the child for work reasons.



**Figure 19:** From the perspectives of the parent and child, a) the worksheet and b) the board game tasks being performed using the ShareTable system.

I deployed the system at Georgia Tech’s Aware Home residential laboratory, an off-campus house simulating a domestic residence [99]. The parent’s ShareTable was located in the home office of the residence, while the child’s version was located in the adjacent playroom, allowing me to simulate the parent and child being apart.

#### 7.3.1.2 Procedure

I familiarized participants with the residential lab and introduced the project. I gave them time to play and experiment with the ShareTable in an unstructured manner. They were encouraged to think about how they would possibly use such a system while apart and to actively try out some of those activities. When the participants were ready to continue, I asked them to perform three separate tasks and fill out a brief questionnaire.

The first two tasks involved completing a worksheet together. The worksheet given to the child consisted of a political map of Africa without any labels, with instructions to color in all countries that began with a certain letter (“M” in the first task, “A” or “Z” in the second). The parent was given an answer sheet—a political map of Africa that contained the names of the countries and their capitals—and instructed to assist the child

in any manner they thought appropriate. For one of these tasks, the parent–child pair was asked to use videoconferencing, while the other task allowed them to use the ShareTable (see Figure 19a). Each parent–child pair completed both tasks, representing a within-participant design, counter-balanced for order effects. I was interested in comparing the strategies that parents and children used with and without the addition of the tabletop video channel.

In the third task, the parent and the child were asked to play a board game together using the ShareTable system. This represents a task that is currently impossible to carry out using a videoconferencing system alone, so there was no videoconferencing condition. I provided a simple game, based on the idea of “Ludo” or “Sorry!” (see Figure 19b). Only the parent’s side had the physical game board, but each side had physical token pieces and a die. Thus, the child had to place his or her pieces on the projected surface of the board. I was interested in whether the child would be able to manage turn-taking and access in this unusual space which interweaves physical and projected artifacts.

After completing all three tasks, I returned to the questionnaire to understand why participants answered a certain way. For example, if a child moderately agreed that using the ShareTable was fun, I probed him or her deeper to explore how the child understood the idea of “fun” and what aspects of the interaction corresponded with or went against that idea. I also asked the participants open-ended questions about their experiences with the system, including what they found confusing about using it, which aspects they liked or disliked, and how they might use a system like this at home. I asked each parent–child pair to commit one hour to this study; however, they were also given the option of continuing to play with the system in whatever way they chose at the end of that time. Throughout the study, two investigators observed each participant and took independent notes, which were later combined for analysis.

### **7.3.2 Results**

My goals were evaluating whether the ShareTable provided any benefit over a plain videoconferencing connection, understanding whether children as young as seven were capable

of managing play mediated by this system, and generating ideas for tasks that families may want to do with the system. To get at these issues, I looked at the following specific questions in my exploratory evaluation:

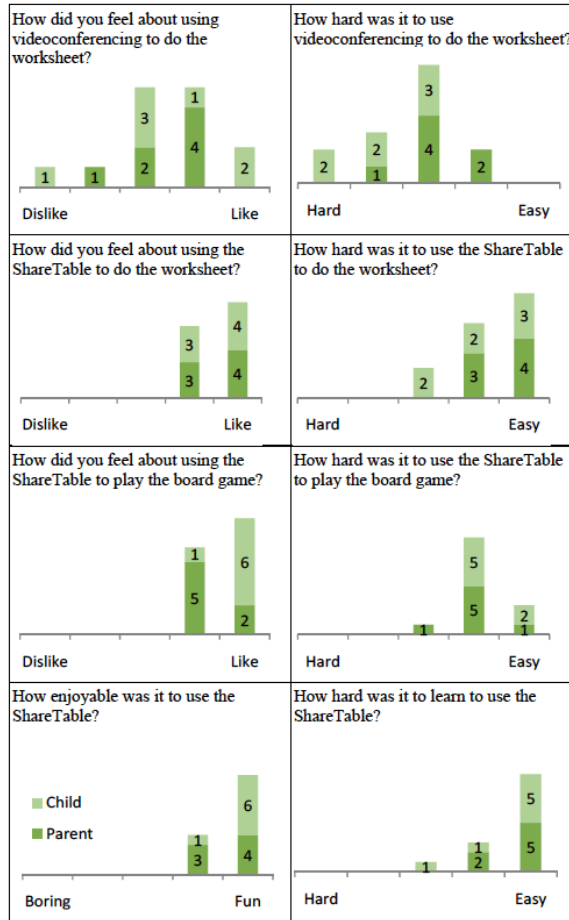
- How do the pairs complete a task using the ShareTable system as compared to using videoconferencing alone?
- How do parents and children coordinate turn-taking and access to artifacts with the ShareTable?
- What activities do the children and parents choose to do when allowed unstructured time to use the system?

#### *7.3.2.1 Comparing ShareTable to Videoconferencing*

I began by observing how parents and children completed two worksheet tasks—one with the ShareTable system and the other with plain videoconferencing. After completing each task, I asked them to answer a few questions about their experience.

I asked each parent and child how difficult it was to do the worksheet with each communication medium and how much they liked using each system on a 5-point Likert scale (see Figure 20). I hypothesized that the ShareTable would be rated as both easier and better liked than plain videoconferencing. I analyzed the results using a Fishers Exact Test, which is appropriate for categorical data (i.e., a Likert scale) with a small sample size [113]. I found that participants enjoyed doing the worksheet task better with the ShareTable than with videoconferencing. This difference was statistically significant ( $p = 0.012$ ), meaning it was unlikely to have occurred by accident. Participants also reported that the worksheet task using the ShareTable was easier to do than using videoconferencing ( $p = 0.001$ ). While this shows that the ShareTable was experienced quite differently than videoconferencing, I was interested in better qualifying this difference. For this, I turned to the observational data.

In the videoconferencing condition, children and parents used the following strategy: the parent would verbally explain where the country is (e.g., “the little one to the left of the big



**Figure 20:** Responses to 5-point Likert-scale questions. Darker color represents parents, lighter color represents children in each bar graph.

one that looks like a heart”), the child would point to the country and hold up the worksheet to the webcam, the parent would confirm or reject the selection, and the child would color in the country if it was confirmed. The main breakdown in the process occurred as the child tried to identify and confirm the country. Several children seemed to assume that the parent could see where they were pointing without holding up the paper (even though it was explained that the parent could not). Several children had trouble understanding how the worksheet would look to the parent when held up to the camera—holding it too close, too far, or even upside down.

In the ShareTable condition, the child would keep the worksheet flat on the table. The parents described the correct countries verbally, by pointing to it with their finger, or by circling it with a marker. Children would verbally confirm if they had the right country or would touch the country with the tip of the marker and look up at the video screen for confirmation. Interestingly, parents did not seem to be concerned with the efficiency of completing the worksheet. None of the parents simply put the sheet with the answers on the table. In one family, the mother explicitly acknowledged that if she showed the answers, she would feel like she was cheating and that her son would probably learn more if they worked through the worksheet together. Another common behavior was taking verbal tangents from the task to tie the worksheet to other experiences in the child’s life. For example, a father pointed to an African country to tell the daughter a story about her aunt who currently lives there. Additionally, every parent made a remark about the country Madagascar and the children’s animated movie by the same name.

It has previously been demonstrated that gestures over video streams can support quicker completion of remote tasks [64]. When one user assists another for work, measures like time to completion make a lot of sense. However, when the users are parents and children, completing the task takes a back seat to engaging with each other. In the ShareTable condition, I noticed a greater level of engagement between the parent and the child. They spent more time looking at each other and less time looking at the task. They also spent more time laughing and talking about peripherally-related information. Parents supported their children’s learning not by making sure that the worksheet was completed

quickly, but rather by tying the activity to other aspects of the child’s life, such as familiar children’s media. By making the logistics of the task easier, I conjecture that the ShareTable freed the parent and child to focus on these other aspects of communication.

### *7.3.2.2 Coordination of Access to Artifacts and Turn-Taking*

To see how parents and children coordinated turn-taking and interaction with the artifacts while using the ShareTable, I asked them to participate in a simple board game task, similar to “Ludo.” Since the ShareTable just projects a video stream, each participant can only physically manipulate the artifacts on his or her side of the table. I wanted to see how participants would manage the interaction of “bumping” each other’s pieces back to start. All but one parent–child pair explicitly verbally acknowledged the possibility of refusing to move their piece when bumped, but quickly dismissed it as it would “ruin the game” or make the game “no fun.” In fact, there was a great deal of physical behavior surrounding the bumping of a piece despite the fact that the participants could not physically replace the opponent’s piece back to the start. A common behavior was manipulating the game token in a “dancing” motion on top of the projection of the opponents’ piece after bumping an opponent.

Unlike an online board game, the ShareTable leaves the management of turns and rules up to the users. While the user was taking his or her turn, they would usually focus on the table surface; however, during their opponents turn, they focused on the face-to-face video. Looking up at the screen at the end of ones turn seemed to signal to the other person that it was his or her move. One interesting facet I observed was that parents tried to bend the rules of the game to the advantage of the child—children won six out of the seven games played. Parents would do this by giving the child strategy advice and by letting them re-do moves or take extra turns. If I had built explicit games and rules into the infrastructure of the ShareTable, this interaction may have been lost.

In post-task interviews, two of the parents explicitly mentioned that, despite the lack of access to the opponent’s pieces, playing the board game using the ShareTable felt much more similar to playing a board game in-person than using any other computer-mediated channel.

Another parent mentioned that after the first ten minutes of using the ShareTable, he felt that he could focus entirely on interacting with his daughter, rather than “using the system.” All of the children I interviewed wanted to try more board games with the ShareTable. Two of them explicitly requested the chance to play again at a later time. In conclusion, parents and children were successful at managing access to artifacts and turn-taking without specific system support—they mutually acknowledged the rules and possibilities of the interface and acted to manage them in a way similar to in-person interaction.

### *7.3.2.3 Observing Unstructured Activity*

I observed the way users interacted with the ShareTable when given an opportunity for free play before and after the tasks. I sought to identify the features of the ShareTable that supported or hindered the activities that the parents and children chose. Several parent–child pairs participated in “collaborative drawing” in which the child or the parent would initiate a drawing while the other added elements to it (e.g., child draws butterfly and the parent adds patterns on the butterfly’s wings). One of the parents mentioned that this task was actually easier with the ShareTable than in-person because she and her son could occupy the central physical location at the table without getting in each other’s way.

I observed a variety of other playful activities. One parent–child pair participated in what I termed “competitive drawing”—the parent would draw something, then the child would cross it out and respond with a different drawing. One family used the surface of the table to “chat” in the way one would use an instant messenger—the child would write a statement, the parent responded to it below, and the child responded in turn. One parent–child pair participated in a “tracing” activity—the father put his hand on the table and the child carefully traced it. In one family, the child played a game of “tag” by trying to catch the projected version of her dad’s hand with her own. One family really wanted to try doing their own task—playing a game of chess with their own board and pieces. I noted that because the ShareTable places the two users on the same side of the table, the father was put in the awkward position of having to play his pieces from the opponent’s side of the board.



In post-task interviews, I asked the parents and children how they would use the system in their own home and if they had any suggestions for modifying the ShareTable. One parent said she wanted her son to be able to leave a short note on the table when he gets home from school. She wanted to be able to access a message left on the table from her mobile phone to quickly get feedback that her son safely arrived at home. Two children mentioned that they would want to use the ShareTable not just to interact with parents, but also to play with their friends. The children who participated in collaborative drawing during unstructured time were particularly excited about the potential of this activity. One child suggested that her father could put printed pictures on his side of the table so that she could trace them. Another child mentioned that he would have liked to be able to share the drawings he and his mother created by giving them to his father to take to work or hanging them on the refrigerator. Both parents and children said that they would use the ShareTable for both play and homework if they had one in their home. Several parents mentioned wanting to be able to read with the child, but three expressed a concern that the resolution of the ShareTable surface would not be high enough to allow comfortably reading most books. However, the most commonly cited concern with the system was the periodic presence of audio echo in the lab setup, which reduced the clarity of audio transmission.

### **7.3.3 Discussion**

One goal of the exploratory evaluation was to serve as a proof-of-concept for the ShareTable system. It also served an equally important role in informing future design and research directions of this work. In this section, I briefly describe the potential changes to the prototype that were informed by the deployment.

#### *7.3.3.1 Improving Audio and Surface Fidelity*

When I asked the participants what they disliked or found difficult about using the ShareTable system, they focused on the fidelity of the connection and the presence of audio echo as deficiencies of the system. The microphone used in the prototype transmitted the speaker output back to the sender, sometimes resulting in an unnerving echo. I have removed audio echo in the current version of the system through use of a unidirectional microphone and



**Figure 21:** Photographs of the improved ShareTable prototype that was developed following the success of the initial deployment.

software filtering. While audio was important to the fidelity of the interaction, the tabletop resolution determined what tasks were possible. Three parents mentioned that the resolution of the table surface was fine for the large-text worksheet but probably too low to read standard-sized text. In the current system prototype, I have upgraded to a high-definition camera that allows print to be clearly visible and still records a reasonably large surface area.

### *7.3.3.2 Leveraging Physical Interaction and Metaphors*

There are many aspects of the ShareTable system that I did not have to consider for this initial deployment, for example, what the system would look like and how calls would be initiated and answered. Through a studio-based brainstorming dialog between two designers, I was looking to consider alternatives in ShareTable construction, interaction paradigms, and use of space in the home. Sketches from this stage are available in Appendix B.<sup>4</sup> Major themes of this exploration included:

- Alternatives for initiating conversation, e.g. opening doors vs. selecting the partner from a list with a mouse

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<sup>4</sup>Berke Atasoy was a major contributor to this design exploration.

- Different arrangements of space, e.g. implementing the system as a play rug vs. a play tent vs. a table
- Alternatives to projection, e.g. using monitor screens for feedback
- Alternative construction and hardware arrangements, e.g. portable variations, modular components, etc.

My final design choices were driven by some of the take-aways from this initial evaluation. One of the things that parents and children reported liking about the ShareTable was the fact that it did not have a traditional interface, but was instead rather similar to non-computer-mediated interaction. To continue building on this theme, I incorporated automatic calibration of the camera-projector system and kiosk-like activation into the current iteration of the system. To attempt to contact the parent or to answer an incoming call, the child must simply open the doors of the cabinet (see Figure 21). To end a call, either party can simply close these doors. As an added benefit, the open doors create a cubby-like area for the interaction, which engenders a sense of privacy.

#### *7.3.3.3 Supporting Semi-Synchronous Interaction*

The term “semi-synchronous interaction” was coined by Dourish & Bellotti [49] to describe systems that support both synchronous and asynchronous modes of work. In a semi-synchronous system, the users can not only work together but also see representations of past activities by others. One of the parents pointed me towards this idea when she suggested that her son should be able to leave messages on the table surface for her. In the context of the ShareTable, the following is a semi-synchronous interaction scenario:

A son attempts to contact his mother using the ShareTable, but she is not available. He sits at the table for an hour doing homework, before leaving to play. He is still outside when his mother attempts to contact him through the ShareTable sometime later. While she can’t get in contact with him directly, she is able to see his homework strewn across the surface of the table. From this representation of her son’s past activity, she is able to determine that he had safely returned home from school and that he may need help with a math worksheet later. She draws a heart on the table and writes “I can help you with this after dinner” by the worksheet.

The above scenario assumes that both ShareTable systems are continually activated. This may not be practical in the home setting for privacy reasons. To address this, I implemented a protocol for semi-synchronous exchanges that does not require an always-on system. When the mother places a call, the shared surface takes a still snapshot of the paired table and projects it onto her surface until her son responds to her call or she chooses to terminate it. Thus, she is able to see a message written on the surface or a note dropped on top of the table without unnecessarily invading the audio and video space of her son's room.

#### **7.4 Conclusion**

My exploration of the problem space of remote parent-child communication, resulted in the ShareTable prototype. The prototype was well received by the parent-child pairs who participated in my study. Interaction mediated by the ShareTable was qualitatively different from interaction through videoconferencing alone. Children as young as seven years old understood and used the system without collocated help. Families saw opportunities for using the ShareTable for both new and familiar activities. Perhaps most telling of all, several families asked how soon a version of the ShareTable would be available for use in private homes.

Deploying the prototype in a controlled environment was helpful to the process of developing the ShareTable. It provided early answers to important feasibility questions and helped generate and prioritize directions for design. As it was meant to do, the exploratory evaluation raised many potential questions for future investigations. A clear next step became conducting a deployment of this system in the households of parents and children who live apart. Such an investigation is the subject of the next chapter.

## CHAPTER VIII

### FIELD DEPLOYMENT OF THE SHARETABLE SYSTEM

Though I initially investigated both divorced and work-separated families, I chose to focus on supporting parent–child separation due to divorce in the context of the deployment of the ShareTable system. The initial evaluation described in the previous chapter showed the potential promise of the ShareTable as a technology to support parents and children in remote play and certain care activities. My previous work also provided me with one valuable tool to understand how the ShareTable might be different from other communication technologies—the ABCCT. But, in order to understand how this system would be adopted by real families, I needed to put the ShareTable in the homes of several families for a reasonable length of time. In this chapter, I describe the four-week-long deployment of the ShareTable system in four Atlanta-area homes and its evaluation using a mix of qualitative and quantitative methods.

#### **8.1 Motivation**

Remote communication with children is notoriously difficult, with most sessions lasting under five minutes and frequently failing to produce any real sense of connectedness (e.g., [12, 187]). More recently, a number of investigations have pointed to the potential of videoconferencing technologies to expand the possibilities of remote interaction with children by providing a context for the communication and allowing activities such as show-and-tell [102, 6, 88]. However, standard videoconferencing is still problematic for many families because (1) initiating a conversation is difficult and cannot be done without at least one tech-savvy adult on each side [6] and (2) interaction over videoconferencing is still focused on *conversation*, which is not the most natural way for children to build closeness with their family [188]. This work contributes to the ongoing efforts of the HCI community to address these two challenges by presenting a field deployment of the ShareTable system, which provides easy-to-initiate videoconferencing and a shared tabletop task space for supporting

activities.

An initial lab based evaluation of the ShareTable showed it to be a promising system for supporting remote parent-child contact [189]. In this work, I present the results of a month-long field deployment of the ShareTable system in four households affected by divorce, where it was used to supplement in-person visitation between parents and children. Three research questions drove my investigation:

- How is the ShareTable used by divorced families?
- How is the ShareTable different from previous technologies used by these families?
- What factors contribute to or detract from the successful adoption of the ShareTable by divorced families?

To answer these questions, I collected data from a number of sources. I gathered pre- and post-deployment measures of relationship quality, emotional costs and benefits of communication technologies used by the family, and communication diaries to understand the lengths, frequencies, and typical topics of conversations. During the deployment, I instrumented the prototype to collect textual logs of system use, as well as video and audio recordings of each communication session. Additionally, throughout the 8 week-study (2-week pre-deployment, 4-week deployment, and 2-week post-deployment), I conducted weekly interviews with each family. I found that the ShareTable more than doubled the amount of time that each family spent communicating remotely, it provided additional emotional benefits without increasing most emotional costs, and it enabled a host of interaction previously impossible for the families. However, the ShareTable also introduced privacy concerns and a new source of conflict as the divorced parents attempted to negotiate practices around its use.

In the remainder of this chapter, I begin by describing the ShareTable prototype in more detail. Next, I give a detailed account of the procedure, instruments, and participants. Then, I relate the findings of my study in the context of the three research questions above. Finally, I discuss the broader implications of my findings and provide directions for future investigations and design.

## **8.2 *System Overview***

The ShareTable system consists of two identical ShareTables, one in the home of the parent and one in the home of the child. To place a call through the system, the user simply needs to open the doors of the ShareTable cabinet. The paired table in the other household rings for 1 minute, as would a phone. To answer the call, the remote user needs to open their cabinet doors. To end the call, either side simply has to close the cabinet doors. Once a call is connected, audio is shared and the monitor screen of the ShareTable shows a standard face-to-face videoconferencing view (large view of the remote participant and a small view showing self). Additionally, the local table surface of the ShareTable now shows a projected view of the remote table surface and vice versa. For example, the child can draw a cat on her side of the table and the child's parent would be able to draw a hat directly on the head of the projected cat on his table. Since the drawings would be aligned and scaled on both tables, both the child and the parent would see the same image of the cat wearing the hat.

### **8.2.1 Hardware**

The ShareTable uses a Dell Inspiron 530s, customized with an ATI Radeon HD 3450 256MB HDMI video card to allow for multiple monitors. The video and audio is captured by a QuickCam Pro 9000 Web Camera. The face-to-face video is shown on a standard 15-inch flat panel monitor; the audio is played on two Dell AX210 Stereo Speaker System. This is essentially a low-cost off-the-shelf system.

The door sensor consists of a Reed switch mounted on the cabinet door and a magnet mounted to the main cabinet of the table. When the Reed switch is close to the magnet, a signal is sent to the system. Since this doesn't require actual physical contact, the sensor is incredibly robust and tolerant to actions such as slamming the door. The Reed switch is connected to an Arduino prototyping board which communicates with the main program via USB.

The ShareTable uses a Dell2400MP projector mounted four feet above the table surface, resulting in a 20" X 16" projection. Commands are sent to the projector using an RS232 connection. When not in use, the projector remained in stand-by mode.

The tabletop surface image is captured by a 207MW Axis Camera at 1024 by 768 resolution and sent directly to the partner table at 5 fps using the Axis camera’s internal server. The cameras were connected directly to the router via a physical Ethernet connection in three of the deployment homes. In the last home, the camera was connected to the router via a networking-over-power-line connection.

Finally, each ShareTable included components to reduce the “visual echo” of the tabletop. In short, without modifying the transmission of the tabletop video, projected images get captured and resent to the originating table. This leads to a “white-out” effect and creates a “trail” from any object that is in motion. I used a polarization solution as a low-tech, robust approach for avoiding recapturing projected artifacts. Each projector and each Axis camera is outfitted with a custom mount for a linear polarizing lens. Projectors thus emit light that is orthogonal to the light that the cameras receive, which breaks the visual echo feedback loop. One last modification keeps the light from depolarizing when hitting the tabletop surface—each surface is covered with a silver lenticular projection screen (the kind used for projecting 3D movies, for example). To protect the screen and to allow the table to be dry-erase marker friendly, the screen is covered in a thin layer of Plexiglas.

Figure 23 shows several photographs of the complete system.

### **8.2.2 Software**

In order to correctly layer the image from the partner table over the physical space of the local table, the ShareTable system must account for the barrel distortion introduced the Axis cameras and crop the image to include only the relevant portion of the view. I modified an existing Python OpenCV solution to generate two matrices specifying the distortion of the Axis cameras after collecting 20 images of a checker-board pattern held at varying angles to the Axis camera. I created a custom Visual C# component that applied these matrices to the image and allowed us to select the relevant tabletop area for each camera. The ShareTable applies these cropping points and de-warping matrices to each image received from the remote Axis camera.

The main ShareTable system is programmed in Visual C# and consists of the following



components: the status database, the face-to-face videoconferencing, the tabletop video, and the logging infrastructure. Each ShareTable must know about the current status of its partner in order to appropriately start and end sessions. To achieve this, each ShareTable pings a MySQL database with its status every second. The face-to-face video and audio is achieved by leveraging the Skype4COM API to initiate a full-screen videoconferencing session. Optionally, the ShareTable could be set to use the TokBox API instead for face-to-face video and audio depending on the constraints faced by the designer (TokBox is much more CPU intensive, but Skype has more strict intellectual property constraints). The ShareTable surface is a C# component that extends the Axis Media Control API to display a cropped and de-warped image (see above) of the partner surface. Finally, the ShareTable logs system use in two ways. First, any time that the status of the system changes (e.g., going from “Call Routing” to “Call In Progress”), a message is added to a text file marking the time and reason for the transition. Second, any time that a call is successfully placed, the ShareTable records video and audio of the local participant and their table surface. The video recording is achieved using a QuickCam Pro 9000 Web Camera mounted on the top shelf of the table. Whenever a call is connected, the ShareTable initiates video and audio recording by issuing a command-line call to Flash Media Live Encoder (used on low-CPU setting). All software for the ShareTable is available for download at [www.sharetable.com](http://www.sharetable.com).

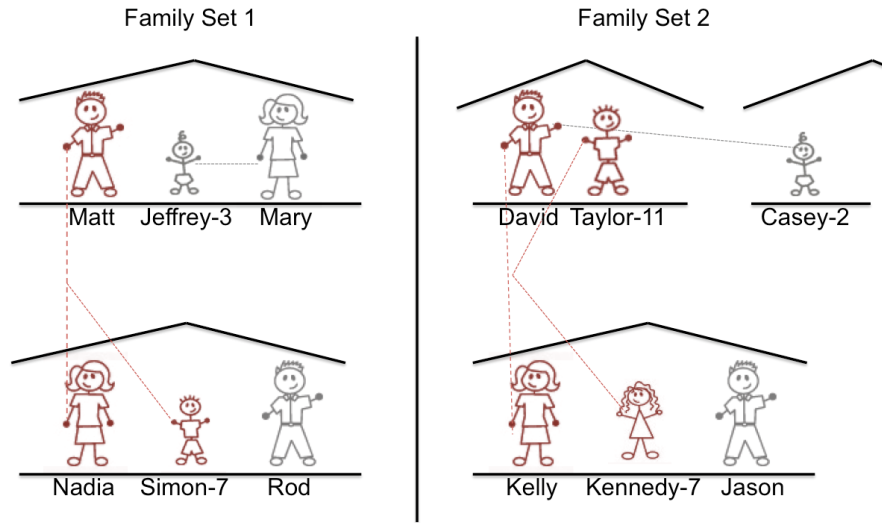
### **8.3 Methods**

The ShareTable was deployed with two Atlanta-area divorced families (four households) over the course of four weeks. The system was evaluated using a mixed-methods approach combining multiple sources of quantitative (communication diaries, system use logs, ABCCT, etc.) and qualitative (weekly interviews, coded video logs of system use) data.

#### **8.3.1 Participants**

All four households participating in this study were recruited through a professional recruitment firm, Schlesinger Associates. The study call described the following qualifications:

- You have a child between the ages of 6 and 9,



**Figure 22:** A representation of relationships and participants in the ShareTable field study. The red figures represent participants directly enrolled in the study while the grey figures are family member who came into contact with the researchers and/or the system but were not formally enrolled. The “roof” symbol groups people primarily residing together. The dashed lines signify biological relationships.

- You live in a different house from the child’s other parent, and both you and your ex are interested in working together to raise the child,
- The child currently talks (in-person or through phone, computer, etc.) with the non-residential parent at least once a week,
- Both you and your ex live within a 3-hour drive of metro Atlanta.

Two additional families responded to the call but one withdrew from the study after the first week due to objections from a step-parent and the second could not participant because no high-speed Internet service was available in the area of one of the households.

#### 8.3.1.1 Deployment 1

Simon<sup>1</sup> is the 7-year-old son of Matt and Nadia. Matt and Nadia have been divorced for 5 years and they currently live a 45–60 minute drive apart. Matt and Nadia both describe their current relationship as fairly low-conflict. Matt is recently remarried to Mary and lives with Mary and Jeffrey, her 3-year-old child from a previous relationship. Nadia is remarried

<sup>1</sup>All participant names were changed to preserve privacy.



**Figure 23:** Photographs showing the ShareTable setup in (A) mother's home in the first family, (B) father's home in the first family, (C) mother's home in the second family, and (D) father's home in the second family.

to Rod and pregnant with Simon’s new half-brother. Simon spends 2–3 nights per week with his father and the rest with his mom; they split the holidays. See Figure 22 for a diagram of study participants and relationships.

Simon and Nadia communicate almost exclusively by phone. Matt and Simon also communicate by phone, but have recently tried videoconferencing as well. Though Matt has purchased the necessary equipment for Nadia’s home, she rarely uses videoconferencing and Matt finds it difficult to do so without her support.

In Matt’s home, the ShareTable was set up in a public space in the living room. In Nadia’s home, the ShareTable was set up in Simon’s room. See Figure 23 A and B.

#### *8.3.1.2 Deployment 2*

Taylor (11, boy) and Kennedy (7, girl) are the children of David and Kelly. David and Kelly have been divorced for 7 years and they currently live about a 60-minute drive apart. Both David and Kelly describe their relationship as fairly low-conflict, especially when needing to make decisions in the best interest of the children. The father is single and Taylor lives with him, spending alternate weekends with Kelly. Kelly lives with her partner Jason and Kennedy. Kennedy spends alternate weekends with David. Taylor and Kennedy see each other every weekend. On school holidays, David and Kelly alternately have both of the children. Additionally, David is the father of 2-year-old Casey. Casey lives with David’s ex-girlfriend but David gets custody every other weekend. See Figure 22 for a diagram of study participants and relationships.

Taylor has his own cell phone and communicates with both of his parents by calling or sending text messages. He also uses Facebook with his parents occasionally. Kennedy does not have her own phone and Kelly’s house does not have a land line telephone, so David usually calls Kelly’s cell phone and she passes it back to Kennedy to talk. Kelly and David have previously attempted videoconferencing on special occasions, but found that it was too problematic to setup the connection and debug when things went wrong.

In Kelly’s home, the ShareTable was set up in the children’s room. In David’s home, the ShareTable was set up in the game room (described as the “man den” of the house).

See Figure 23 C and D.

### 8.3.2 Procedure

The procedure for the ShareTable deployment consisted of three parts: (1) pre-deployment interviews and diaries, (2) deployment with interviews, diaries, and logging, and (3) post-deployment interviews and diaries. Through all three parts of the study, I kept detailed field notes of each visit and collected photographs where appropriate.

#### 8.3.2.1 Pre-Deployment

Before the ShareTable was deployed, I interviewed each family. I spoke to any children over 6 who live in the house, both of the parents, and any cohabitating current partners. The questions focused on current strategies that each family uses to stay in touch and the specific challenges of their arrangement.









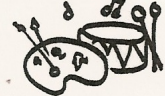











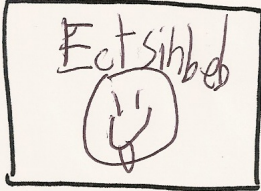

I collected responses to a number of validated questionnaires to get a baseline for each participant. I asked each parent to fill out a Network of Relationships Inventory (NRI) [62] describing their relationships to their past partner, current partner, and the children participating in the study. I asked each child to fill out a shortened NRI inventory (shortened by presenting only one question from each scale of interest) describing their relationships with their parents and any step-parents. For each communication medium that the family used regularly, I asked both the parents and the children to fill out an appropriate version of the ABCCT (see Chapter 6 and [192]).

Finally, I provided each member of the family with a diary notebook and asked them to log any remote contact between the parent and the child. The adult version of the diary (given to the parents and the 11-year-old participant) consisted of noting the length of communication, the medium used, recording the topic of the conversations and an affective reflection (see Figure 24). The child version of the diary asked the child to circle the time of day, medium used, topic of conversation, and their feelings afterwards. The child could also draw or write additional information in the provided space (see Figure 25). Each family kept these preliminary diaries for at least 14 days. I visited each household weekly to go over the diaries and ask each member to expand on the provided entries.

<p>Date: 12-21</p> <p>(If applicable)          Started: ~ 15m          Ended: ~</p>	<p>How did you talk? Telephone Computer <u>ShareTable</u></p> <p>What did you talk about?          we talked about what [redacted] was doing on her vacation and about what we would be doing next week when she is here. Of course we talked about Christmas.</p> <p>How did you feel after the talk?          Excited about her coming. It had been a few days since I seen her so it was good to see her again.</p> <p>If you DO NOT want this video viewed by the researcher, check here: ____</p>
<p>Date: 12-22</p> <p>(If applicable)          Started: ~ 10m          Ended: ~</p>	<p>How did you talk? Telephone Computer <u>ShareTable</u></p> <p>What did you talk about?          Just took a chance to see if [redacted] was near the sharetable and she was. We just talked about her day, and when we could talk again. [redacted] and I talked about a few issues</p> <p>How did you feel after the talk?          Relieved for Christmas to get here so I can have all my children here with me.</p> <p>If you DO NOT want this video viewed by the researcher, check here: ____</p>

**Figure 24:** This is an example of a communication diary given to any participants over the age of 10.



When we talked:	How we talked:	What we talked about:
 Morning	 Phone	 About School
 Day	 Computer	 About a Trip or Visit
 Evening	 Another Way	 About Art or Music
		 About Sports
		 Saying "Goodnight"
		 Told Jokes or Laughed
		 About a Book
		 About How I Feel
		 About a TV Show or Movie
		 Saying "I Love You"
 Okay		
 Happy		
 Sad		
 Angry		
 Something Else		 Something Else

**Figure 25:** This is an example of a communication diary given to any participants under the age of 10.

During the last week of the pre-deployment, I worked with each family to decide on the best location for the ShareTable (the decision was mostly influenced by an availability of a 3' by 4' floor space) and I coordinated with each family to install Comcast Business Class High-Speed Internet service for the duration of the study. The particular plan chosen was advertised by Comcast to provide speeds up to 50 Mbps download and 10 Mbps upload. However, using an online service to clock the actual speed, I found that the families were usually getting between 5 Mbps and 8 Mbps upload speeds.

#### *8.3.2.2 Deployment*

The ShareTable was installed in each home and the system was briefly explained to the participants using example scenarios. I also explained that the system would log use and video record any ongoing calls. However, videos were only stored locally and participants could mark any session for deletion—I would delete this session's video in front of them without watching the video. Participants were provided with a new set of diary logs that included the ShareTable as a medium option on the diary and that had the additional option for marking a recorded video for deletion. I asked participants to continue keeping communication diaries and I continued weekly interviews with participants for the next 28 days.

At the end of the 28 days, each participant was asked to fill out an ABCCT questionnaire for the ShareTable and another NRI describing their family relationships.

In the final interview before removing the ShareTable, I conducted a workshop with each household to ask them to consider synchronous communication technologies for families, suggest new directions, and consider how they would redesign the ShareTable. Finally, I also asked each household to give some advice to the next family that might use the system.

#### *8.3.2.3 Post-Deployment*

The post-deployment protocol was different for family 1 and family 2. Family 1 chose to withdraw from the diary study after the ShareTable was removed, because the mother's life was hectic with the arrival of her newborn baby. However, I continued phone and email correspondence with the father to understand how the family's use of technology and



communication practices changed after the removal of the ShareTable.

Family 2 continued the post-deployment study as planned. For the next 14 days, they continued keeping communication diaries and I conducted interviews by phone (with the father’s household) and by Skype (with the mother’s household).

### 8.3.3 Analysis

There were a number of quantitative (or at least, quantifiable metrics) gathered through the course of the study: ABCCT responses, NRI responses, and descriptive statistics of log and diary data. Because of the low number of participants in this study, I focus on general descriptive statistics in reporting of this data rather than hypothesis testing. I present only those aspect of the data that are meaningful to the overall research questions of this project, however all anonymized quantitative data is available upon request.

There were numerous sources of qualitative data in this study: field notes, interviews, video logs, and diaries. All four sources of this qualitative information were transcribed and an initial round of open-coding and memoing was conducted on all four of these sources of information. I followed the qualitative analysis process described by Seidman to create thematic connections using a data-driven approach [155]. I extracted statements of interest and other points of evidence (e.g., rich descriptions from field notes, etc.) and grouped these together by theme. I conducted three such passes through all of the data, refining the themes with each pass until a set of distinct themes emerged. Though the process was largely data-driven, I was also influenced by the research questions I posed at the outset of the study:

- How was the ShareTable used?
- How was the ShareTable different from previous technologies used by these families?
- What factors contributed to or detracted from the successful adoption of the ShareTable?

After conducting the qualitative analysis, I grouped the themes by the major research question they addressed (with some themes appearing in more than one section). This is the structure I use in the results section of this chapter.

### 8.3.4 Limitations

As each ShareTable deployment required a significant commitment of resources and as only one working prototype of the system exists, it was only possible for us to recruit four households. It is difficult to generalize from such a small data size and such a small N makes most forms of statistical analysis impractical. However, the benefit of the small sample was that it allowed us to conduct a more in-depth study (e.g., weekly interviews) and a more detailed analysis (e.g., transcribing all video logs) than would have been possible with a larger group.

Perhaps more problematic, the study may not have been long enough. I estimated that a four week deployment would be adequate as this is the average length of a field deployment for family communication technologies (see Chapter 6). However, one participant expressed that it really wasn't long enough for him:

“I think we really needed it for longer in order to figure out how to use the table. When you first play around with it, it's too new. We did try a few games like tic-tac-toe and stuff, but I think now that it's gone, I keep thinking of things that we should have done and tried. Well, like the other day, I thought that it would be perfect for Pictionary! And I keep coming up with things like that now that it's gone!” David

Perhaps because this system is significantly different from what is currently available, the families may have benefited from a longer deployment. Unfortunately, limited resources combined with the time-related costs of the deployment contributed to the initial decision and the limitations of this choice are only evident in retrospect.

My study required families that were both relatively low-conflict (at least low-conflict enough to agree to participate in a study together) and had at least one young child. This combination was found to be difficult even for a professional recruitment firm. Though my original intention was to select several interesting case studies that varied on a number of dimensions, I was instead limited to the families that responded to the call. The most notable factor missing from my data is information about families that live further away and do not see each other very frequently. Additionally, there was inevitable self-selection bias in the recruitment process, as most evident by the technical nature of the participants

(three of the four parents were involved in IT fields).

Another limitation is that I was only able to collect self-report data for the pre- and post-deployment communication. This was particularly problematic for the second family where lengths of sessions were frequently estimated on diaries. In weekly interviews, I asked the family to specify the length of the session within a range that they thought would definitely include the actual length (e.g., “longer than 5 minutes, but shorter than 10”). I use the upper range of these estimates in the quantitative reporting to make sure that I do not overestimate the effect of the ShareTable on communication session lengths. However, one mitigating factor on the limitations of this self-report methodology is that I collected two different diaries for each session (one from parent, one from child) and was able to detect and correct inconsistencies through the interview process. Since all diaries matched up with an appropriate pair at the end of the study, I am confident that the number of sessions is accurately represented.

Because the ShareTable is a relatively early prototype that combines a number of different technologies (e.g., projector, sensors, videoconferencing, video recording, etc.), it did not work perfectly all the time. In fact, something went wrong in 9 out of the total 24 sessions with the ShareTable. These problems included choppy face-to-face video (Skype problems), projector taking more than 3 minutes to warm up and start, one of the surface cameras failing to connect (thus one person could see the other’s table, but not vice-versa), audio being too low, and tabletop video being out of focus. In three of these 9 cases the users contacted me directly and I was able to correct the system through remote access, thus the rest of the session proceeded unhindered. However, in the remaining 6 cases the families used the system as-is, thus missing out on potential benefits of the ShareTable. It is a testament to the families’ persistence and patience that they were willing to put up with these problems and continued using the ShareTable despite experiencing these troubles.

Finally, as in all such deployments [24], there is a strong potential for the observer effect and demand characteristics to bias the final findings. For example, the parents might feel the pressure to perform as a “perfect parent” for the researcher, thereby increasing the number of communication sessions and changing their content. I hope that including the

pre- and post-deployment sessions mitigates this influence since the observer effect should be present in both of these parts as well, thereby dropping out of the analysis. There was little I could do to mitigate the demand characteristics in this field deployment, other than emphasizing that the system was not complete and I needed lots of concrete critiques to make it better. Indeed, in the trial I saw both evidence of “investigators as participants” and “participants as investigators,” as described by Brown et al. [24]. The participants oriented to my interests as an investigator, for example children seemed to be most eager to talk to the remote parent immediately after the interviews (four separate examples of this in the data). I also saw the fathers frequently take on the role of the “lead participant,” encouraging others to use the system and even documenting its use for my benefit (e.g., photograph in Figure 26 was taken by the father). Brown et al. recommend a number of changes to how HCI researchers conduct and report data from field trials to help moderate these effects: diversifying methods, moving beyond success vs. failure analysis of the trial, emphasizing the unique characteristics of each participant, and rejecting reproducibility [24]. I act on all four of these recommendations when describing the results of this study in the next section.

## **8.4 Results**

The results section organizes the themes from the qualitative analysis of interviews, diaries, and video logs to provide evidence relevant to each of the three research questions driving this study:

- How was the ShareTable used?
- How was the ShareTable different from previous technologies used by these families?
- What factors contributed to or detracted from the successful adoption of the ShareTable?

Where appropriate, I also refer to relevant data from quantitative analysis of the diaries and surveys.



**Figure 26:** Simon, Jeffrey, and Rod use the ShareTable to draw. Photograph taken by the father, Matt.

### 8.4.1 ShareTable Use

I hypothesized that the ShareTable would support a number of joint activities by providing both face-to-face video and a shared workspace. In fact, I saw a number of different uses of the system, many of which would be impossible without a video connection and some of which would be impossible without the shared surface (See Figure 26).

#### 8.4.1.1 *Drawing Together*

Drawing together was the most common way that the families in the study used the surface, perhaps because this was an activity that they reported enjoying when collocated. For Kennedy, it was her favorite thing about the ShareTable: “It’s just so cool! I like drawing on it.”

Frequently, there was a playful and collaborative nature to the drawing, as the remote participant tried to guess what the local participant was producing. Simon frequently leveraged the ability to synchronously share his drawing as it was being created by asking his father to guess at its nature.

Simon: Awesome! Cool, cool. Look what I drew.

Matt: Yeah, what is that. Is that DNA?

Simon: No, it’s like... Oh wait, it kind of does look like DNA.

Matt: That’s what I said...

Simon: Except there’s no lines... Just wait one second, it’s almost done... Let’s see...

Matt: Yep, there’s the DNA.

Simon: You like it?

Matt: Yes.

Simon: [Jeffrey], look at my DNA!

After Matt provided an interesting suggestion, Simon changed his drawing to play along. After the drawing was complete, he called over his younger brother (remotely) to take a look and participate.

Throughout the study, there were seven different examples of contact where children and parents drew on the table for each other.

#### 8.4.1.2 *Supporting Learning*

Parents have frequently described the frustrating interaction of trying to engage in their child’s learning experience remotely (e.g., [187]). However, throughout the ShareTable deployment, I saw five different examples where parents could engage with their child’s learning experience beyond the traditional “‘What did you learn in school today?’ ‘Nothing’” exchange (there were many examples of this exchange as well, but they are not included in this analysis).

For example, in one video, Simon and his mother practice math problems by writing on the surface of the table:

Nadia: Good job! Let me give you one.

Simon: Give me a math problem I’ll write it.

Nadia: OK. [Writes on the table]

Simon: It has to be a big one.

Nadia: [Laughing] It’s a plus. [Waits for him to write out the answer]

Nadia: That’s right, Babbo. Good job!

There were five different examples where parents and children discussed something that they learned or learned new things together. However, only two of these examples leveraged face-to-face or tabletop video. The other three involved only audio: a question-answer session, a quiz, and practicing singing a song in a foreign language.

When I initially conceptualized the ShareTable system, I anticipated considerably more activity around homework help [189]. In fact the idea of homework help was one that was compelling to the parents in this study:

“I especially want to use it to go over homework. I feel like the other house has been slacking and [Simon] hasn’t been keeping up with it. I’d love to look at the homework and get him to practice his spelling and all that.” Matt

Two aspects of the system and the deployment prevented this from being a more common activity. First, the participants found it really difficult to read small text over the surface of the table. Though I did provide 1024 X 768 resolution for the surface (best possible under bandwidth constraints), this was barely good enough for 16 point text and

completely impractical for anything smaller. Though most of the younger children’s (Simon and Kennedy) worksheets were viewable under these constraints, it was too straining and it was much more practical for these families to defer this task until they could be together. Second, in family 2 the deployment fell over a school holiday for the children. Even though this was a compelling use case for the father, it was not one he got an opportunity to try out:

“The holidays made it weird. It would have been cool to have it here once school started back up for both of them. Especially, with [Kennedy], it would be great if she could show off a drawing that she made in school or if [Taylor] could show me a good grade that he got on a test.” David

However, despite the fact that this activity was not as common as I anticipated, it was encouraging to see that parents and children could use the ShareTable to engage in learning activities.

#### *8.4.1.3 Playing*

Interaction over the ShareTable was inherently playful, however unstructured playful activities were much more common than structured games. The only structured play we saw were four separate examples of playing tic-tac-toe. Other types of play was more focused on playful actions and show-and-tell.

Playful actions were frequently spontaneous and child-initiated. In this example, Taylor playfully moves his hand in a wave motion. His sister Kennedy first tells him to stop, but then decides to get in on the fun. They go back and forth for several minutes, attempting physical actions that are more and more complex:

[Taylor puts his hands together and moves them in a back and forth wave motion]

Kennedy: [Taylor], stop doing that wavy thing.

Taylor: Uh-uhhh ... Ready, [Kennedy]?

Kennedy: Yeah...

Taylor: Ready, [Kennedy]? Ready? Look. Forward, reverse. Forward, reverse.

Kennedy: [Tries to do the same] Forward, reverse. Forward, reverse.

Similarly, the parents were also at times drawn into this playful physical show-and-tell activities (though, they seem to be less likely to join in):



Simon: Hey, you want to see this? Watch my eyes. You ready?

Rod: Yeah [laughs]

[Simon tries to roll his eyes so that only the whites of his eyes are showing]

Jeffrey: Those are zombie eyes.

The ShareTable became a venue for the child to show off new skills and playact new stories with toys. There were five separate examples of playful show-and-tell, including puppets, baby dolls, and showing magic tricks. For example, Simon shows a new magic trick to his father:

Simon: So you see this weird thing too?

Matt: Yeah, I see that.

Simon: I'm going to put this thing on the thing.

Matt: Umm-hmm.

Simon: Snap, One, two, three... It's a ball!

Matt: Oh wow! Look at that. That's a good trick, [Simon]!

Simon: Watch ... One, two, three.

Matt: Umm hmmm! Very good trick. I like it.

Most of these examples used the face-to-face video as a primary view, however in two of the cases the tabletop view was used as well to provide the parent with an opportunity to "touch" a particular toy that was being shared. For example:

Kelly: Where is your baby doll? Or, what's her name?

Kennedy: Her name is Daisy.

Kelly: Where's Daisy?

Kennedy: I'll go get her...

Kelly: Oh, there's Daisy! [strokes Daisy's hair on the tabletop]

All in all, I saw thirteen separate examples of explicitly playful behavior in the recorded videos. Two of these involved mostly audio (e.g., doing funny accents to each other), five involved primarily the face-to-face video (two physical playfulness and three show-and-tell), two involved both the face-to-face video and the tabletop (show-and-tell), and four involved primarily the tabletop (all cases of tic-tac-toe).

#### 8.4.1.4 Coparenting

Coparenting is a term used to describe the activity of parenting together, when both of the parents provide care and discipline to the child [47]. This is seen as a particularly rare occurrence in divorced families, where the most common approach is “parallel parenting” (dad’s house, dad’s rules; mom’s house, mom’s rules) [5]. Partially, this is a consequence of the fact that it is difficult to provide care or discipline remotely [188]. However, I saw several examples of coparenting in the ShareTable video logs. For example, David and Kelly collaborate to convince Kennedy to clean her room after David sees its state over the ShareTable face-to-face video:

David: You need to clean your room, princess!

Kelly: Yeah, she needs to give away to feel better. She needs to go through her room today and pick some toys to give away so that she gets new ones. Otherwise, Santa won’t have any room, right?

David: Yes, I’m going up there to inspect your room and if it isn’t clean, it’s not a good thing.

Kennedy: Okay, okay, okay...

Kelly: But you don’t mind right, [Kennedy]? You don’t mind giving away some of your toys to those in need to make room for some new ones, right?

Kennedy: No, I don’t.

There were four other examples of both parents parenting together from family 2 throughout the course of the videos. There were also six additional examples from family 2 where one parent remotely provided care or discipline for the child, for example:

Kelly: Oh, hey, let me see. Are all of your teeth still there, [Kennedy]? Yeah? Okay, just making sure. Are you brushing them?

Kennedy: ... Umm ...

Kelly: [Kennedy], you gotta brush those nasty teeth! ...

Kennedy: No. I’m gonna brush my teeth today.

Kelly: Okay, that’s a great idea.

While there was only one example of coparenting in first family’s video logs, there were four additional examples of the remote parent providing care or discipline for the child. Interestingly, it seemed that Simon felt confident in turning to a remote adult to resolve a local situation. For example, when Jeffrey tries to take the markers from the table:

Simon: No, give back the markers! [tries to wrestle them away] [Rod], can you make him give me?

Rod: Play nice and share half of them, okay?

The pre-deployment diaries did not provide the amount of granularity necessary to see the amount of coparenting present before the ShareTable deployment, so no clear before and after comparison is possible, however it was encouraging to see that this type of interaction was possible and relatively common over the ShareTable.

#### *8.4.1.5 Sharing Physical Items*

The tabletop was most frequently used to show physical objects to the partner. One aspect of being a child from a divorced family is having two homes with two mailing addresses and two distinct locations for all of your physical belongings [131], so mail became a common object to be shared using the tabletop surface. For example, David described a particular interaction with Taylor:

“[Taylor]’s gaming magazine came while he was at [Kelly]’s and I put it on the table. He wasn’t able to read the text, but he could see the pictures. So, we were able to look through and see what would catch his eye, because you know that Christmas is coming up.” David

Similarly, Matt shared a card from a grandparent with Simon using the ShareTable system. This meant that the card could be shared on the appropriate holiday (Halloween), rather than waiting for the next in-person visit several days later:

Matt: Grandma sent you a card, actually, a Halloween card. Do you want to wait till you get it or do you want me to open it?

Simon: Open it.

Matt: OK, it says... “Cooked up these happy wishes, especially for you. Because it’s that time of the year, when you send a happy boo. Happy Halloween, Love Grandma and Grandpa.” See? Look!

Simon: Cool!

Matt: And, you get to see this ... this is also in it.

Simon: Oh, a check! How much is it?

Matt: What does it say? Grandma and Grandpa sent you a \$5 check!

One benefit of the ShareTable over holding an item up to the face-to-face camera is that the object can remain on the table for the duration of the conversation, until noticed. This particularly worked well for family 2, where interactions typically involved three or more people at the same time, tending to get hectic, and a shared item would otherwise be overlooked:

Kennedy: Look at at what daddy did to my nails? [hands on table]

[About 5 minutes of other conversation passes between Kelly and Taylor]

Kelly [looks down]: Oh my god, [Kennedy]! Your nails! [points to Kennedy's hand] Are these your nails, these long ones?

Kennedy: No, they're fake. Dad put them on.

Throughout the logged videos, I saw seven separate examples of sharing physical items using the surface ShareTable. There were three cases of mail being shared, one case of showing off painted nails, two cases of showing toys and games on the surface (only counting cases of showing, not playing), and two cases of homework/school items being shown.

#### *8.4.1.6 Sharing the Moment*

Family 2 frequently used the ShareTable to share moments of everyday life and special moments rather than for scheduled communication.

Several times, the father would call the children over the weekend before a sports game that all three of them were planning to watch. Even though the ShareTable was not used during the actual game, the father found this to be a compelling interaction:

"We ended up talking around noon and before the game. So, that was almost like we were watching the game together!" David

The father's communication with the children in family 2 was generally spontaneous. As such, the children frequently included him in whatever they were doing, rather than interrupting their activity to talk. In one moment, Taylor shares playtime during a friend's visit with his father, while Kennedy narrates:

Taylor: Look, this is a game that me and [my friend] made up...

[Taylor and his friend begin tackling each other in the background]

Kennedy: Look. It's so funny! They tackle each other as boys.

Taylor: Then we start punching each other! [laughter and yelling]

The second family celebrated Christmas towards the end of the deployment period. The ShareTable became the medium for the children to share the excitement of the moment and show off their newest presents to their father:

Kennedy [yells]: Daddy!

Kelly: You don't have to scream.

David: Hey, baby!

Kennedy [still yelling]: I'm gonna go get my Bedazzler!

[Taylor is sneaking up behind Kennedy to try to wrestle her away from the screen]

David: Don't let [Taylor] come get ya!

Kennedy: I'm gonna go get my Bedazzler!

David: You got a Bedazzler? [to Taylor] Hey, main man.

Taylor: Hey, dad!

David: I guess that's your phone right there? [points to a phone on the table]

Taylor: No, that's not my phone.

Kennedy: My Bedazzler. Look. It's my Bedazzler! See it! See it! Daddy, did you see my Bedazzler?

Taylor [puts his shoe on the table]: I got new shoes!

David: Let's try not to get those painted.

Taylor: I know.

Kennedy: Daddy, look! My Bedazzler! Oh, here, look. These are bedazzled. [Puts a bedazzled shirt on the table.]

Kelly: She's bedazzling everything now.

I saw this activity more in the second family than in the first, because the former incorporated spontaneous messaging into their practices with the ShareTable. In the first family, Mike attempted to initiate similar sessions (e.g., calling late on Halloween hoping to see the candy that Simon received during trick-or-treating), however all of these connections were usually rejected by Nadia. Mike would always call or text Nadia before making a ShareTable contact, so it was easy for her to serve as a gatekeeper for the in-the-moment interaction.

#### *8.4.1.7 Emotional Care*

Perhaps the most common type of interaction with the ShareTable focused not on a specific activity or topic, but rather on building closeness and communicating love. I saw examples

of this in both families, but family 2 most clearly articulated the importance of this style of communication.

Kennedy pointed this out as the main difference between the phone and the ShareTable:

Kennedy: I like that you can see the other person and you can hug them.

Me: You can hug them?

Kennedy: Yeah, just hug the screen and they see it on the screen and on the table. And we can give kisses!

Perhaps the best example of this type of interaction was seen in the video logs as Kelly talked to Taylor while he wasn't feeling well:

Kelly: [Taylor]! What's going on, baby?

Taylor: Well, my throat is acting up...

Kelly: Awww, well take care of yourself. Go to bed, go to sleep now. Because you have a very busy day tomorrow. What else is wrong, sweetheart? You look like you're really sad, honey!

Taylor: I'm not.

Kennedy: Here, [Taylor]. Have a thermometer. [Puts a thermometer up to the monitor]

Kelly: [laughs weakly] [Kennedy], don't break the thermometer. Put it back.  
[Strokes Taylor's hand on the table]

Taylor: I just don't feel good.

Kelly: Alright, well listen. I love you. You really just don't feel good, is that all it is? Are you sad about anything else?

Taylor: No.

Kelly: Do you see my hand, holding on to your hand?

Taylor: Yes, I do.

Kelly: I love you, baby.

Taylor: I love you too, mom.

Kennedy: Hey, Bubba.

Kelly: There's my hand. Keep your hand in there, we're going to do a family handshake, okay? [Kelly, Kennedy, and Taylor put their hands on the table together]

The face-to-face video was key to Kelly noticing that Taylor may have been more sick than his voice sounded, but it was the ShareTable surface that allowed her to act towards him to convey emotional care through "physical" touch.

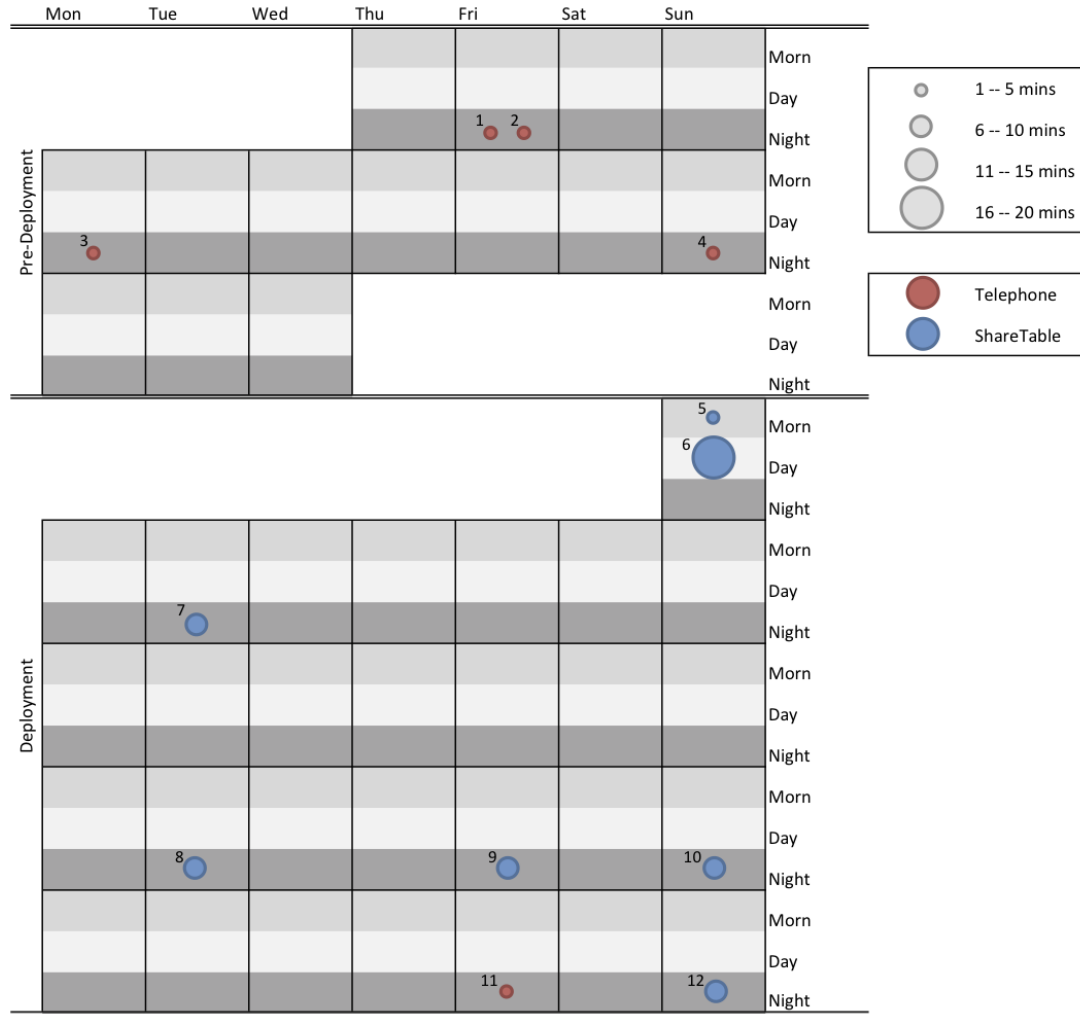
Family 1		
	Pre-Deployment	During Deployment
Avg. Minutes / Week	5.25	17.50
Avg. Session Length	2.63	8.75
Avg. Sessions / Week	2.00	2.00
Initiated by Child	0%	12.5%
Family 2		
	Pre-Deployment	During Deployment
Avg. Minutes / Week	14.98	33.67
Avg. Session Length	7.50	7.35
Avg. Sessions / Week	2.00	4.58
Initiated by Child	14.3%	64.3%

**Figure 27:** The lengths and frequencies of communication between the children and parents before and during the ShareTable deployment.

All in all, there were 20 separate examples of “emotional care” interaction in the video logs. Most of these were fairly brief kisses or hugs towards the end of the conversation. However, four separate cases were longer interactions as the one above. Of those four, three involved “touching” hands on the ShareTable surface.

#### 8.4.2 Comparing ShareTable to Previous Technologies

One of the goals in deploying the ShareTable system was to understand how this system is different from the other communication technologies routinely used by the families in the study. In the pre-deployment phase, I asked the parents and children to keep diaries of remote communication. Family 1 collected four diaries over the course of 14 days. All four described telephone calls. Family 2 collected seven diaries over the course of 21 days (the extra week of pre-deployment was due to a delay in getting the ShareTable installed). Six of these described phone conversations, while one described an SMS exchange. Both families continued keeping communication diaries during the deployment. Family 1 recorded eight conversations in a 28-day period, with seven of those being over the ShareTable. Family 2 recorded 17 conversations in a 26-day period, with all but one of those using the ShareTable. Figure 27 shows the overall statistics on the amount of time each family spent communicating, showing the weekly average for each family increased more than two-fold. It may be interesting to note that family 1 had the same number of conversations before and during the deployment but the length of the average conversation increased.

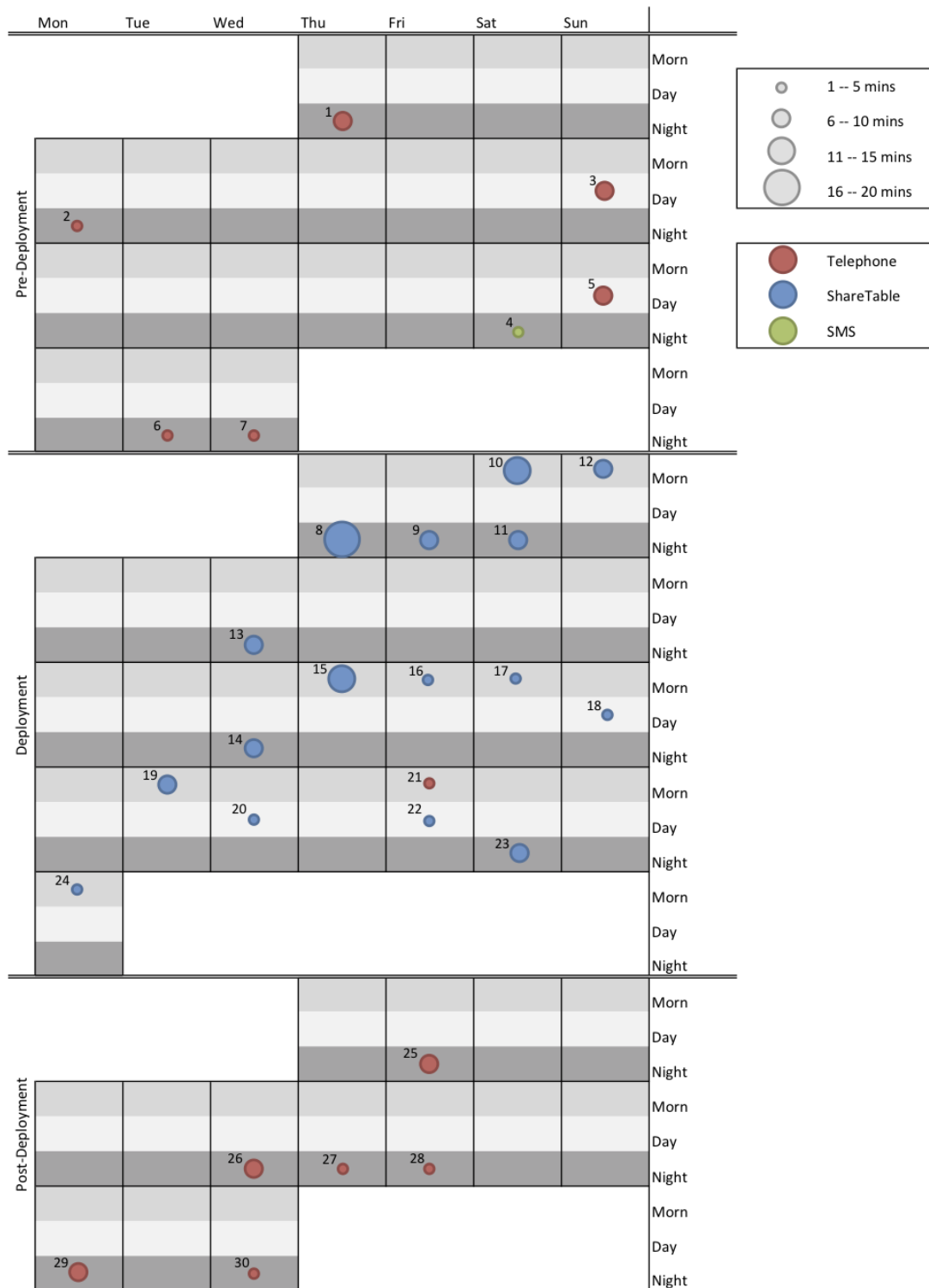


**Figure 28:** This shows all communication session for family 1. The labels in this figure correspond with the labels in Figure 30.

Figures 30 and 28 show the specifics of each communication session before and during the ShareTable deployment. Family 2 saw the opposite effect—conversations were roughly the same length (though, as I stated in the limitations section, this length of telephone calls may be overestimated) but they were more frequent. Figures 31 and 29 show the specifics of each communication session before and during the ShareTable deployment. It is also important to note that children initiated a significantly greater proportion of conversations during the ShareTable deployment.

I asked each parent and child in the study to complete a Network of Relationships Inventory before and after the deployment [62]. The parents completed one for the remote





**Figure 29:** This shows all communication session for family 2. The labels in this figure correspond with the labels in Figure 31.

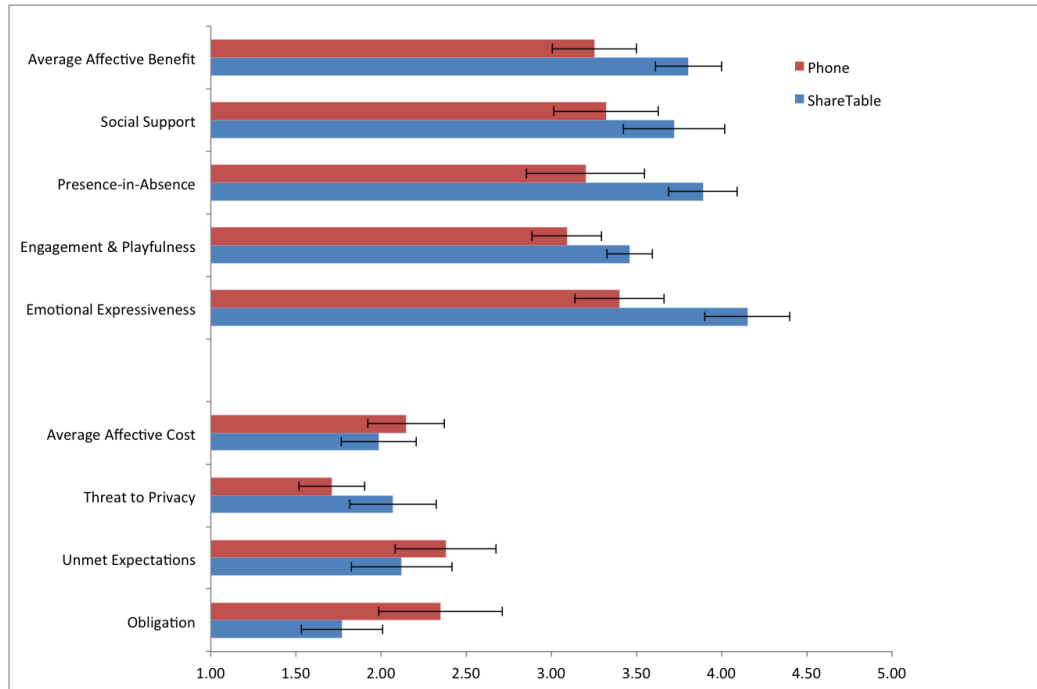
	1*	2*	3*	4*	5	6	7	8	9	10	11	12
Matt	*		*	*	*	*	*	*		*		*
Simon									*			
Nadia		*									*	
Rod												
Jeffrey												
Other												

**Figure 30:** This shows all communication session for family 1. The labels of the horizontal axis in this figure correspond with the labels in Figure 28. All participants of a particular session are shown in green, with the initiating participant(s) starred. Stars next to session that were recorded exclusively through diaries and/or interviews (pre- and post- sessions) indicate that the data was post-hoc self-report only.

	1*	2*	3*	4*	5*	6*	7*	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25*	26*	27*	28*	29*	30*
David		*	*		*							*		*	*	*		*						*						
Kelly	*						*	*														*				*	*	*	*	*
Taylor				*			*		*	*	*		*	*								*				*	*	*	*	*
Kennedy								*	*	*		*	*				*	*	*	*	*		*							
Casey																						*								
Other																														

**Figure 31:** This shows all communication session for family 2. The labels of the horizontal axis in this figure correspond with the labels in Figure 29. All participants of a particular session are shown in green, with the initiating participant(s) starred. Stars next to session that were recorded exclusively through diaries and/or interviews (pre- and post- sessions) indicate that the data was post-hoc self-report only.

child, for their former partner, and for their current partner (if re-partnered). The children completed one for both of their biological parents and any step-parents. The NRI uses a five-point Likert scale, asking the participant to evaluate different aspects of the relationship. Here, I will highlight those aspects that changed by more than 1 point before and after the deployment. The most striking changes can be seen in Taylor's inventory, who reported a more supportive relationship with his mother and a less antagonistic relationship with both his mother and father. In interviews he reflected that much of the antagonism was previously due to the fact that he did not call enough—an issue significantly eased by the ShareTable. Kelly (Taylor's mom) reported a greater sense of intimacy with him after the deployment. The ShareTable also seemed to have the same effect on David's relationship with Kennedy. There were no differences exceeding 1 point on Kennedy's inventory, but this is perhaps due to a ceiling effect—she reported the highest possible value on positive characteristics and the lowest possible value on negative characteristics on both surveys before and after the study. Family 1 reported few changes on their NRI. Simon reported



**Figure 32:** The results of the ABCCT survey describing the telephone vs. the ShareTable.

a higher level of satisfaction in his relationship with his father, but there were no other positive changes. There was a negative change that Nadia reported in her sense of reliable alliance with Matt. It seems that the table did introduce some conflict for this family that was captured by the NRI. Overall, the ShareTable may have contributed to some positive relationship outcomes for both families, though also some potentially negatives ones for family 1.

The families in the study were aware of the challenges of using the phone to talk to a child even at the onset of the study. As David said, “the phone is really too short and it’s so easy to get distracted and want to go do something else.” This is consistent with findings from previous investigations (e.g., [12]). However, these families also faced additional challenges due to tensions introduced by divorce:

“Kennedy doesn’t have a phone and her mom doesn’t have a land line, so I really have to call Kelly to talk to Kennedy. And that’s awkward and I really can’t even call every day and even when I do, it’s for about 5 minutes, no more.”  
David

“Some days are okay, but one day we really weren’t getting along and [David] can be really a [problem] about it. He just won’t pick up the phone when I call.

He wasn't picking up and [Taylor]'s phone was turned off or dead or whatever so I had no way of contacting him." Kelly

One possible reason for the increased communication time during the deployment of the ShareTable system is that the children could initiate conversation or answer incoming contact independent of the collocated adult. In fact, the percent of time that children initiated remote interaction in family 2 went from 14.3% before the ShareTable (one conversation was initiated by the child) to 64.3% (nine conversations) during the ShareTable deployment. The detailed data about the initiation and participation of each communication session is presented in Figures 30 and 31.

One contribution of this work is pointing out the specific factors that may make the phone less effective than videoconferencing technologies like the ShareTable. Figure 32 presents the results of the ABCCT questionnaire comparing the phone and the ShareTable. Overall, the ShareTable scored higher on each measure of benefit and lower on all but one measure of cost. Of most significant note, the ShareTable created fewer unwanted obligations to communicate, supported greater emotional expressiveness, more engagement & playfulness, and a greater sense of connectedness outside of the actual interaction (presence-in-absence) than the phone. These findings were also confirmed in the interviews. For example, one parent stated:

"Just in general, having the interaction is better. It's more fun and more like just killing time together ... It definitely makes it easier to keep it engaging for more than five minutes." Kelly

It may have been more interesting to compare the ShareTable with videoconferencing, as the differences may have helped better understand the role of the shared surface. However, the truth of the matter is that the main difference between the ShareTable and videoconferencing is that the first was used while the second was not. Though both of the families in the study reported trying out videoconferencing, neither family used it routinely (and not a single pre-deployment diary from either family described a videoconferencing session). The father from family 2 articulated the problem:

"We've attempted videoconferencing before and Facetime, but really we only tried a couple of times ... Video is nice, but getting it to work from both the

ends wasn't worth it. We'd have the phone going, and I'd be saying 'hit that thing on the right' or whatever. It would take forever to get it set up ... we literally spent an hour and a half setting up a call which lasted five minutes. It gets to the point when it's not worth it. So, our main method is the phone." David

It seems that without an easy way to initiate and answer a connection, videoconferencing was simply not a usable solution for these families. In fact, these results are consistent with findings from other studies. In the study described in Chapter 5, I found that while nine out of 14 families had tried videoconferencing, only five of those used it regularly (and even then, mostly infrequently).

Despite the fact that it was impossible for me to quantitatively compare the use of the ShareTable with the use of videoconferencing (since there *was* no use of the latter), interviews revealed that the participants saw the surface as a significant component of the interaction that was different from the previously-available technologies:

"But, when we *did* connect with the ShareTable, it really added an extra depth dimension and another layer to the experience. I was surprised by how different it was from trying to do something like an online white board together. It was definitely a different layer to the experience." Matt

"I feel like the table itself makes up the difference. There's just something about it, when you put your hand there and your daughter puts her hand on top, where you feel like you're almost touching. It's like, now I know why you called it the ShareTable. You really feel like you're sharing the moment." David

Overall, the ShareTable was successful in increasing the amount of remote contact for the two participant families and was recognized by the participants as a compelling medium for communication. In the next two sections, I examine in more detail the aspects of the system and its adoption that contributed to its success versus those aspects that presented challenges or detracted from its maximum potential.

### **8.4.3 Factors Contributing to Successful Adoption of the ShareTable**

Throughout the four-week deployment, I asked the participants to reflect on their use of the system in weekly interviews. These results provide some insight about the aspects of the ShareTable that were most important to its successful adoption.

#### *8.4.3.1 ShareTable Session Is Easy to Initiate*

Each of the parents commented on the easy-to-initiate nature of the ShareTable. For example, David said that this was one of the aspects that differentiated the ShareTable from other videoconferencing systems:

“The other thing is the idea of how you just open it up and ‘boom!’ It was instant! We’ve tried Facetime. We’ve tried to do videoconferencing on the TV. We’ve tried Skype. But, the ShareTable was just so much more convenient. It was too much hassle with the other stuff. But this, you actually ended up using it.” David

Designers may not think of a log in screen as being a big barrier to adoption, but it seems that even something small as this can be a barrier to a quick or spontaneous call:

“Well, I think the biggest thing is just being able to just open the doors and connect. We don’t have to log in or anything. It’s just already there.” Kelly

The fact that the ShareTable was a dedicated system, rather than one of many programs on a computer, meant that it was possible for anybody to use it without worrying about doing something wrong, affecting somebody else’s data or files, or making a mistake with big ramifications. As Mike said:

“The other thing is that I really like how the ShareTable is not just a computer program; it’s really an integrated piece. Just knowing that it only has one function, looking at it as an appliance. You turn it on and it just shows you stuff!” Matt

It appears that participants appreciated the strategy of leveraging the physical metaphor of a cabinet to simplify the interaction of initiating a videoconferencing session.

#### *8.4.3.2 Children Used ShareTable Independently*

One of the factors that contributed to the increased number of communication sessions in family 2 is that the children initiated a larger proportion of the calls. David explained that the ShareTable has a “cool” factor that the kids loved:

“Oh my god, the kids LOVE it. They almost love it too much. They gave me a call last weekend at like 8 am! I wanted to sleep, so I said, call back at 10 and they did. But, it’s definitely getting the kids more motivated to talk! It’s cool! It’s so cool that getting to use it is almost like an incentive to stay in touch more regularly.” David

It seemed the “coolness” of the ShareTable increased children’s motivation for communication. As Taylor said:

Me: In what ways has the ShareTable changed the way you stay in touch?

Taylor: It was more like “Yeah!” Like you wanted to do it.

Even in family 1 where few conversations were initiated by the child, it was now possible for Simon to use the ShareTable without the help of a collocated adult. Nadia reported:

“No, I didn’t help them at all. I wasn’t there, they did it on their own. I did hear it ringing and I knew that [Matt] was going to call because he always text me before he calls, but I wasn’t in the room at all for it.” Nadia

The relationship between the parent and child is typically characterized by asymmetric motivations to communicate [42] and difficulty communicating without the aid of a collocated adult [187]. It seems that the ShareTable may help address some of these challenges.

#### *8.4.3.3 ShareTable Supports Multiple Users on Each Side*

One of the benefits of videoconferencing is that multiple people can easily join in conversations on each side. In past investigations, participants have mentioned that this makes it more fun and easier to find topics for conversation (e.g., [6, 187]). I saw evidence for this effect with the ShareTable as well, for example Kelly explained:

“It’s more fun and more like just killing time together. I also like that when we talked the one time, it was really all four of us talking, not just [Taylor] and I. So, we could really joke and laugh all together ... it was definitely fun!” Kelly

By analyzing the video logs, I was also able to gain insight about *why* it was so beneficial to be able to have multiple participants on each side.

First, when a collocated adult joined in the conversation, they could help the child and clarify any uncertainties:

Simon: What are you drawing?

Rod: You can’t see?

Simon: Yeah, I can see, but what is it?

Matt: Looks like a Ninja Turtle to me.

Simon: Oh, yeah. He’s kicking. And there’s his arm.

Second, when step- or half-siblings take part in the conversation, children revel in the opportunity to introduce family members who don't usually interact. For example, Simon loved introducing his step-father to his step-brother:

Simon: Do gibberish!  
Rod: You do gibberish!  
Simon: No, you do it to [Jeffrey]!  
Rod: [makes gibberish noise]  
[Jeffrey laughs]

Seeing others in the background sometimes provided new contexts for conversation that may have contributed to longer sessions when using the ShareTable than over the phone. In one example, Kelly was concluding her conversation with Taylor and saying good bye. However, as Taylor's baby half-sister appeared in the background she was drawn into the conversation.

[Kelly sees Casey in the background, after saying good bye to Taylor]  
Kelly: Hey, [Casey]! Can you say hi? Take out your 'paci' and say hi?  
Taylor: Say, 'Hi!'  
Casey: Hi!  
Kelly: Hey, [Casey]. What are you doing?  
Taylor: Say 'Nothin'  
Casey: Nothin'

Even after Casey ran off to play, Taylor and Kelly continued talking for another four minutes. Casey's fortuitous appearance in the background nearly doubled the overall length of that interaction. There were four other examples in the videos where after saying good bye the conversation would be renewed after seeing or hearing the background activities of another family member (typically another child) and drawing him or her into the conversation.

#### *8.4.3.4 ShareTable Surface Opens Up New Possibilities for Remote Contact*

In addition to easy-to-initiate videoconferencing, the ShareTable provides a shared tabletop space. This was a feature that was particularly valued by the children in the study (perhaps more so than the parents):



Me: What are your favorite things to do with the ShareTable?

Kennedy: Draw on it! [Points to Kelly] I think hers is just looking at [Taylor]'s face.

Kelly: Yes, I'd say just being able to see the person and see what's going on.

Me: What were your favorite things to do with the ShareTable?

Taylor: Definitely something that used the projector, like playing tic-tac-toe and stuff.

"I just feel like it is so good when it works that I *have* to use it. It's so good to be able to write stuff and see each other." Simon

While children were more likely to note the surface as the "must-have" feature of the ShareTable, two of the parents also expressed that the surface supported a more natural interaction:

"Well, there's really an added dimension to it. Using the table adds a large value! We've tried using online white boards together before but it's really not as organic as the ShareTable. There's something organic about a table that's otherwise lost. It's really an extra valuable dimension!" Matt

The video logs showed three out of the four parents using the surface to foster an emotional connection by holding hands, giving a "low five," tracing each other's fingers on the table, etc.:

"I feel like the table itself makes up the difference. There's just something about it, when you put your hand there and your daughter puts her hand on top, where you feel like you're almost touching. It's like, now I know why you called it the ShareTable. You really feel like you're sharing the moment." David

The surface was universally the favorite feature of the three children in the study. The parents also saw the value of this feature, but saw it as just one of the features (or "dimensions") that made the ShareTable work.

One way to unpack the relative importance of the ShareTable surface is to examine the cases where the tabletop did not work as intended. Between the two family deployments, there were 3 situations where ShareTable surface did not work at all (neither side could see what the other was doing on the table) due to malfunctions with the projector or the networked cameras. The average length of the conversation in those three situations

was only 2.5 minutes, compared to 8.1 minutes in situations where the tabletop did work. Additionally, in interviews, the participants expressed that this was disruptive. For example, Matt said that he was “definitely a little disappointed that I couldn’t show him the card that I got from his grandma on the table.” It seems that the surface may have contributed to longer conversations and was something that the parents relied on having available to use.

#### **8.4.4 Factors Detracting from Successful Adoption of the ShareTable**

Throughout the deployment, I also asked the participants to reflect on the aspects of the ShareTable and its use that didn’t work well for their family.

##### *8.4.4.1 Insufficient Bandwidth for Clear Image*

The most commonly cited problem with the ShareTable was that the image was not clear enough, whether in the face-to-face video or on the surface:

“I’ll be honest that sometimes we get choppy signal or the video skips a bit on the screen.” Matt

Me: What do you think are the most important things to fix about the ShareTable?

Kelly: Well, it really just has to be faster and have a better connection. The tabletop was sometimes fuzzy or out of focus and the face-to-face video would frequently freeze.

This was simply a limitation imposed by the amount of bandwidth required by the ShareTable system (especially, to send high-resolution images of the tabletop). The cameras above the ShareTable surface, captured images at 1024 by 768 resolution. While this was an adequate resolution to read large-font text (greater than 16pt font), it simply did not work for tasks that David may have wanted to do with Taylor:

“I think the only other thing was that the table wasn’t always clear enough. I thought that we would do more sharing of pictures and things like that. But if you put a regular book on the table, I really couldn’t read the words, I could only see the pictures.” David

Interestingly, none of the participants noted the low frame-rate of the tabletop surface (5 fps or less) as a cause of disruption. It seems that objects placed on the table were

usually not in motion, so perhaps even a lower frame-rate may have been tolerated at the expense of a higher resolution.

#### *8.4.4.2 Interrupting Household Routines*

A big concern with the ShareTable was that remote contact may interrupt routines in the home:

“...you know if his dad calls, that just kind of means that [Simon] has to disengage from us in order to engage with his dad.” Rod

In family 1, all contact was preceded by a telephone call to the mother to make sure that no household routines would be interrupted. Even when a ShareTable call was planned and a ShareTable connection was established, there were several times when the collocated parent decided that it wasn’t a good time to talk:

Matt: I didn’t get you guys at a bad time there?

Nadia: Well, I mean. Normally, we’re at the church at this time but we’re really busy today, so ...

Matt: Oh, all right ... Well, I’ll catch you later.

Nadia also cited concerns over interrupting the other household as the main reason she kept contact with Simon to a minimum while he was visiting his father:

“The last thing is that I didn’t use it that much and that was mostly because I feel guilty using it. We have [Simon] the majority of the time, so when he’s at [Matt]’s, I want to respect that and give them time to be together. I feel guilty about calling and taking away from that time.” Nadia

By contrast, in family 2, the remote parent prioritized continued contact over the worry of interrupting the other home. While this did lead to more frequent use of the system, it also created conflict as routines were disrupted:

“I did end up calling too early. You’ll see mom yelling in the video because I called too early.” David

“If you leave it up to a child, they really just go ‘Ahhh!’ and use it all the time. Sometimes it felt like it was like ‘Enough calling! He just got to my house!’” Kelly

Neither arrangement was ideal for the ShareTable. In family 1, contact with the child was curtailed to minimize conflict with the other parent. In family 2, the ShareTable became a new source of conflict in an already-tense situation.

#### 8.4.4.3 *Privacy Concerns*

The ShareTable introduced additional concerns about privacy, especially when compared to the phone (see Figure 32). Only one of the parents explicitly stated her concerns in the interview, but this seemed to be a big barrier to adoption for her:

“For us, it just might not be worth it. There’s just the privacy issue. It’s like you’re always on speaker phone. If you’re on the phone, you’re the only one that can hear it and they can’t hear what’s going on around you. But with the ShareTable ... It’s like this. I think [Matt] had it in his living room. And then, they could really hear everything that we said and we could hear what [Mary] was saying too.” Nadia

Based on Nadia’s comments, I provided head phones for the second family. However, the second family did not choose to use them and did not state any privacy concerns during or after the deployment.

Though none of the other parents explicitly discussed privacy in interviews, Rod and Kelly also seemed concerned about the number of cameras when the ShareTable was being installed and wanted to know exactly when and how video would be recorded. For both Rod and Kelly, the primary concern seemed to be protecting their privacy from researcher rather than protecting it from the other household.

#### 8.4.4.4 *Conflict over Appropriate Practices*

The ShareTable introduced a new source of conflict over appropriate practices around this communication system. One disagreement focused on the appropriate setting for the system:

“I feel like right now, [Simon] would have to be in his room to hear when I call [Nadia’s house]. Here, it’s set up in a public space, so one of us hears it and lets him know, but there, unless he’s in his room, I have to call first.” Matt

“I’d say that it needs to be in a private room, especially if the divorced parents don’t get along as much as we do.” Nadia

“If I had known that this would be the outcome of putting it in [Taylor]’s room—that [David] feels like he can call night and day—I would have probably put it in the living room so that I could have more control over when it gets used.” Kelly

“We never established a time. We called whenever because it was in [Taylor]’s room. I definitely say if you call at any time, you have to put it in the kid’s room so that it doesn’t interfere with the parent.” David

It seemed that David was the only parent satisfied with the placement of the system in the other household, all others thought that the ShareTable would be better off in a different location. However, despite the disparate viewpoints presented, it seems that the general requirements of each parent are not contradictory. The ShareTable should be in a location (1) where the ringing could be heard by the child, (2) where the privacy of the other family members is respected, and (3) where both the remote and the collocated parent have an appropriate amount of control over when it gets used. However, the last aspect is the most problematic one and caused significant disagreement in deciding what is appropriate:

“I think that right now, this kind of thing would only work for people with a good relationship already. Otherwise, it will just end up causing more drama. It sort of did this in our case, at certain times.” Kelly

In both families, the arrangement that was established did not work well for at least one of the parents. In family 1, the arrangement was to always call ahead and whether it was a good time to talk would be decided by the residential parent. This worked well for Nadia, but really curtailed available communication time for Matt:

“[Matt] and I are fortunate that we are both fairly reasonable, but with most families custody is always a big issue. We really try to think about it and arrange communication with the other person in mind. That’s why [Matt] always messages me before calling—to make sure he’s not interrupting anything.” Nadia

“I think that the biggest problem for us wasn’t the technology at all, it was actually the social coordination aspect of it. Just the scheduling. It seemed like it was really hard to get on. I always tried to call [Nadia] first or at least text or something to let her know what I’d be trying to ShareTable later, but that didn’t always work. I think they’d frequently be out of the house or couldn’t talk when I called.” Matt

At the end of the study, I asked Nadia and Matt if they could recommend a better arrangement for the next family who would use the ShareTable. Both agreed that an ideal arrangement would be a set time every week to use the system:

“One of our problems is that we couldn’t coordinate when we’d be home and he’d be home and we could actually use the system. I think it would be best to just have set times.” Nadia

This suggestion was passed on to family 2 before the ShareTable was deployed. Family 2 tried to heed this suggestion, but the conversation about setting a time got derailed early on, so the dad got in the habit of calling spontaneously. This arrangement worked for David but not for Kelly:

“Well, it’s really not about the ShareTable but about [David]. We get many more unexpected calls. If I had known that this would be the outcome of putting it in [Taylor]’s room—that [David] feels like he can call night and day—I would have probably put it in the living room so that I could have more control over when it gets used.” Kelly

“Well, I’d say that our arrangement worked really well. We didn’t really have a set time, but I could hear the ShareTable anywhere so the kids could just call any time. It would always be a pleasant surprise when they called and the kids definitely wanted to talk more.” David

After the deployment, Kelly and Taylor both agreed that an arranged time would have served the family better:

“I would say, that it would be good to set a time to call. I would say like 6 o’clock, when everybody is home.” Taylor

“I think it would be more successful if it was more structured and had some rules and set times. Like, let me know ahead of time if you will call and always call between 9 and 10 pm or something.” Kelly

However, David maintained that the existing arrangement worked well and Kennedy also said, “I like getting [spontaneous] calls!” Unfortunately, the ShareTable can only work for a family in the longterm if all members can agree on acceptable practices.

#### *8.4.4.5 ShareTable Requires Uninterrupted Time in Front of the System*

The last problem with the ShareTable was one that has been previously cited [187] for videoconferencing in general—it requires uninterrupted time sitting in front of a non-mobile system:

“It’s such a great idea and I’d love to use it more, but it really requires me to sit down and be there to use it. We’re so busy ... I need to make time for it. Both of us really have to be home and available. Even on weekends, I work on Saturdays and we’ve got church on Sundays. With the phone, you can pick it up even if you’re in the grocery store or something.” Nadia

Kelly also cited this as a reason she did not use the system as frequently as she may have wanted. She usually used the weekend that the children were at their father's to run errands and take care of commitments outside of the house:

“They were at their dad's this weekend, but I was literally out of the house all weekend so I didn't talk on the ShareTable...” Kelly

David also mentioned that the ShareTable was more difficult to use during extremely busy times than the phone may have been:

“I thought that we'd end up using it a lot over Christmas, but we really didn't. I think that's because we were just really too busy here and always all over the place.” David

It seems that the ShareTable has not addressed a fundamental problem with desktop videoconferencing—it requires time spent in front of the system.

## **8.5 Discussion**

In this section, I draw across the findings of this investigation to suggest that the ShareTable is valuable as an artifact that provides emotional context, not just as one that provides an activity context. I consider the success of the ShareTable in terms of the “languages of love” framework to show why it may have been so well-suited to support remote parenting. I discuss issues of privacy, control, and conflict uncovered in the deployment and how such challenges may be addressed when the ShareTable is used outside of a study context. Lastly, I provide some implications for design of future synchronous communication systems for parents and children in divorced families.

### **8.5.1 Emotional Context Rather Than Activity Context**

I initially anticipated that the main benefit of the ShareTable surface would be in supporting activities between the parent and child. While it did in fact make it possible for the families to play tic-tac-toe, draw together, share a magazine, do math problems, and more, this was not the main benefit of the surface. It seems that the ShareTable surface was most successful because it provided a shared video space—one where a remote and a local object could be placed one on top of the other. The most important use of this space was not

for helping with worksheets (which were too hard to read anyway), but for holding hands and feeling together. The main benefit of the ShareTable surface was in providing a way to “share the moment” (David) rather than share an activity. Olivier & Wallace considered the design of technological artifacts that could help a family communicate abstract ideas such as closeness and memories, providing several prototype ideas that had “no specific function or purpose” but rather focused on the family as an emotional entity [135]. Though the ShareTable seemed to have a very specific purpose—supporting the parent and child in participating in activities remotely—in its appropriation, it was more similar to Olivier & Wallace’s ideas.

My initial conception of system use was overly influenced by the controlled nature of the lab study that preceded this investigation [189]. Instead of the structured and ordered one-on-one activities, there was loud and hectic jostling for space between family members. Discrete activities were difficult to identify. Much of the contact was focused not only on the activity over the ShareTable but also on the activity around it. The parents paid attention to the children who were actively using the ShareTable and the children who were playing around in the background or just going about their daily activities in the house. Drawing additional partners into the conversation made the interaction both longer and more engaging for the participants. The strength of the ShareTable was in providing context for the parent–child interaction, both through the easy-to-initiate videoconferencing and through the “added dimension” (Matt) of the surface. Providing a conversational context has previously been identified as being incredibly important for sustaining family communication [52]. In this study, it seemed that the ShareTable provided both a conversational context and an *emotional* one, letting the remote parent briefly enter the (at times hectic and chaotic) life of the children on the other side.

### **8.5.2 Applying Languages of Love Framework to Understand ShareTable Use**

Kaye borrows a non-academic framework of the Five Languages of Love to apply as a lens for understanding how families use, perceive, and benefit from videoconferencing [91]. This framework focuses on the five ways in which people express their love for each other:



**Words of Affirmation** expressing feelings of love and comfort in words

**Quality Time** giving focused attention to each other, for example having dinner together or playing a game together

**Giving Gifts** giving physical or digital gifts to the partner

**Acts of Service** doing things for each other, such as driving to soccer practice or preparing a special lunch

**Physical Touch** physical contact, such as hugging or tickling

In the deployment of this system all five “languages” are clearly present in the use of the ShareTable. The ShareTable affords greater emotional expressiveness than the phone and sessions frequently involved both verbal and symbolic expressions of love and comfort. Because the ShareTable requires uninterrupted time in front of the system and because it encourages engagement and playfulness, it became a source of quality time spent together as a family. Though gifts were not physically given over the ShareTable, it became a medium for remotely sharing received gifts (such as greeting cards and Christmas presents). The ShareTable supported coparenting and care interactions which were forms of acts of service from parent to child. However, Kaye noted clear examples of all four of the above languages of love from videoconferencing technologies as well [91]. Perhaps where the ShareTable stands out the most is in supporting a type of metaphorical video touch that the participants described as “almost touching” (David). Even though the ShareTable is quite different from the remote touch technologies considered in the HCI domain (e.g., [23, 141]), it was successful at conveying an emotionally-meaningful sense of physical touch. The ShareTable was successful for the two families that used it because it supported all five ways in which people express their love for each other.

### 8.5.3 Privacy, Control, and Conflict

Though the HCI community has been exploring technologies for divorced families through interview studies (e.g., [131]) and including divorced families in deployments (e.g., [43]), generally most deployments focus on more amicable types of family separation (e.g., grandparent-grandchild). This study may provide insight on how communication technologies are adopted in situations where privacy and control may be of paramount importance to users and conflict is a fundamental aspect of the relationship.

Privacy was much less of a problem in this study than may have been predicted. Only one participant reported privacy to be a major issue, and even then she was more worried about violating the privacy of her partner than about protecting her own. However, this may in fact be due to the relatively low-conflict nature of the participating families and may be a much greater issue for high-conflict families. In essence, the ShareTable makes the room where it is placed part of both the local house and the remote one. It may be hard for family members to develop practices around such a “cybrid misfit” [7]. Overall, it seems that the best place for such a system would be in the child’s room, as that is the most likely candidate for shared room between the two houses. However, in order for it to work well in that setting the families still need to develop a reasonable agreement about appropriate times for calling and the call announcement needs to be propagated to a space where the child frequently spends time (which is often not in the bedroom).

In this study, parents struggled to control the amount of remote contact with the child. Too much remote contact interrupts household routines and takes time away from interacting with the local parent. Too little remote contact cuts the parent out of the life of the child and does not provide the remote parent with opportunities to share in the joys and burdens of child-rearing. The two deployments represent two contrasting cases: one where the local parent limited the interaction considerably and another where the remote parent’s spontaneous contact became a point of conflict. In both deployments, one parent ended up feeling slighted by the adopted practices. In the end, use of the ShareTable and similar technologies should be treated as a “virtual visitation” practice [41]. As such, decisions over its use need to be made explicitly and potentially with the help of a court-appointed

counselor who can advise the parents in an objective manner.

As it was, the ShareTable did introduce additional conflict into the lives of the families in the study. However, as these families had been divorced for a number of years, they had become quite accustomed to handling such disagreements. In the end, none of the four households rejected the technology. In fact, the ShareTable became the medium for almost all parent-child communication throughout the deployment. The benefits of this technology were seen to outweigh the costs introduced by increasing tensions over appropriate practices around its use.

#### **8.5.4 Implication for Design**

There are lessons to be drawn from the successes of the ShareTable that can be applied to other communication technologies, as well as alternative system ideas that can help address some of the challenges that using the ShareTable presented for the families in this study.

**Plug-And-Play Easy-To-Initiate Videoconferencing.** As a community, we have not thought a lot about the process of initiating a videoconferencing connection. While ethnographic studies have acknowledged the difficult “work” behind videoconferencing [6], most studies of communication technologies have not addressed this issue. In field studies of such systems, the issue has been avoided through always-on connections (e.g. [89]) or by assuming that a parent will help set up the session (e.g. [145]). This may work for some families, but certainly not for all. One of the big factors that contributed to the ShareTable’s use was that the connection was very easy to initiate. There was no log in screen, no user list, and no way to contact or be contacted by the wrong person. This meant that children could use the system without adult supervision. This benefit is not limited to an information appliance like the ShareTable. In fact, it would be easy to create a simple USB device that would reduce the connection process to pushing a single button and that would allow a child to use existing software such as Skype by automating large portions of the connection process based on parent-created settings. For maximum benefit this system would still need to be a dedicated system residing in a space where the child frequently spends time, however it would be easy

to recycle an old laptop or desktop system in such a way and it would provide much of the benefit of the ShareTable at a small fraction of the cost and complexity.

**Shared Overlapping Video Space.** One of the most valuable aspects of the ShareTable was the ability to overlap the local and remote spaces in a way that supported emotional interactions, such as holding hands. In fact, there is something powerful about *sharing* the video space rather than a standard videoconferencing window-in-window view. Other studies have noted the power of a shared video arrangement for creating a feeling of shared narrative [56] and for simplifying perspective taking on the part of the child [191]. In this study, I saw another benefit—this arrangement created a greater sense of closeness and a good metaphor for physical touch. In fact, a camera-projector system is not required to create this sense. Simply displaying the participants at the same scale on the screen, subtracting the background, and overlapping a portion of the video would let participants give virtual high-fives, pinch a cheek, or even pick each other’s nose.

**Encoding Rules for Interaction.** However, not everything about the ShareTable worked well. The main problem with the ShareTable was a difficulty in developing practices around scheduling use that would provide ample opportunities for interaction without disrupting the routines of the child’s household. The majority of the participants in the study agreed that best arrangement would be a scheduled time for interaction, however I should also point out that at least one parent really valued the opportunity to be spontaneously contacted by his children. In order of this system to be accepted by high-conflict divorced families, it is likely that rules for interaction will have to be determined with the help of a court-appointed counselor. The benefit of a custom communication system is that the rules for interaction can actually be explicitly encoded. For example, a family may decide that the non-residential parent may only initiate a call between 6 and 7 PM on a weekday, but that the child may initiate interaction at any time. This rule can be added to the connection code, so that no session may be initiated outside of these rules.

**ShareTable On-The-Go.** Lastly, participants mentioned that it was frequently inconvenient to only be able to use the ShareTable while at home. Before the deployment, several parents mentioned that they would “pass back” the phone to the child while driving or running errands to allow him or her to talk to the remote parent while the local parent was occupied with other activities. A mobile system that incorporates some of the benefits of the ShareTable, such as providing overlapping video (as described above) and an easy-to-initiate connection may increase children’s opportunities for interaction with their parents. Additionally, as mobile Internet speeds become better with many 3G and 4G enabled cities, it may be a compelling option to integrate communication systems into existing media capabilities of family cars (e.g., parent’s mobile phone connects to the backseat video screen).

## **8.6 Conclusion**

I deployed the ShareTable—a system that provides easy-to-initiate videoconferencing and a shared tabletop task space—with two divorced families in the Atlanta area. Throughout the month of its use, the families employed this technology to participate in shared activities (such as drawing together) and share emotional moments (such as Christmas morning). The ShareTable increased the amount of time spent communicating by more than 100% for both of the families and seemed to have some positive effects on the parent–child relationships in these homes. The ShareTable provided a number of emotional advantages over the phone and was much easier to use than standard videoconferencing. However, it did also introduce concerns over privacy and new sources of conflict about appropriate calling practices. Overall, the ShareTable seems to represent a promising direction for “virtual visitation” technologies once modifications to the system help ameliorate some of these concerns.

## CHAPTER IX

### DISCUSSION

In this section, I draw across the findings, lessons, and underlying assumptions of the work discussed up to this point. I begin by discussing my epistemological perspective in investigating family communication technologies, pointing to how this perspective guided my process and discussing why this may be a valuable perspective to take the context of family communication. I discuss the findings across the previous studies by examining parenting through the lens of Activity Theory. Finally, I provide an agenda for future work in connecting parents and children who live apart.

#### ***9.1 Segmented Institutionalism as a Perspective for Understanding Family Technologies***

The definition of “family” is shifting. The nuclear conception of the mother, father, and children living in the same household has given way to an infinite variety of extended, distributed, blended, and unconventional families. It is a challenge to design for this moving target, but not one without precedent. At an analogous stage in the development of organizational computation for the workplace, social scientists reflected on the development of two complementary views of computing: system rationalism and segmented institutionalism [103]. System rationalists extolled efficiency and excelled in stable settings, while segmented institutionalists assumed conflict and radical change to be inherent and succeeded in more dynamic circumstances. I draw on this historical parallel to extend the segmented institutionalist perspective, proposing it as a tool for understanding and responding to the rapid evolution of family technologies and the social structures they aim to support.

Hirschheim & Klein posit that the information system developer’s basic epistemological assumptions become manifest in the practice of system design and evaluation [79]. Burrell & Morgan delineated the two dimensions that define these epistemological paradigms: objective–subjective and order–conflict [28]. The objective paradigm posits a quantifiable,

classifiable external reality. On the other hand, the subjective paradigm rejects “hard” classification of facts and universal laws of the social world, often allying with qualitative methods that emphasize the interpreted nature of reality. Both views are represented in designing for families, though the popularity of methods like ethnography, participatory design, and the probes point to a stronger endorsement of the subjective spectrum. The order–conflict dimension presents two models for interpreting society: “sociology of regulation” and “sociology of radical change.” The first is concerned with stability, integration, functional coordination, and consensus. The latter is interested in change, conflict, disintegration, and coercion. I posit that diverging motivations and tensions that characterize family relationships have been largely overlooked in previous designs for families. I propose a more inclusive alternative perspective by connecting with another epistemological framework.

Kling compared social analyses of computing in work organizations between 1950 and 1979 and found two distinct camps of study [103]. The system rationalists emphasized the positive role of computing in improving the efficiency of organizations. On the other hand, the emerging camp of segmented institutionalists examined both the “legitimate” and the “illegitimate” consequences of computing by studying all stakeholders, including non-users. While the rationalists emphasize agreement on goals, the institutionalists assume stakeholders have overlapping and conflicting objectives and motivations. Many current designs for the family echo the system rationalist approach: (1) focusing on improving family efficiency (e.g., [127]), (2) assuming consensus on family objectives (e.g., [134]), (3) including only direct users in the evaluation (e.g., [89]), and (4) having an optimistic view of the impact of computing technology (e.g., [26]). While this is a reasonable lens for many family designs, a different perspective—segmented institutionalism—is offered at the intersection of the conflict and the subjective paradigms. Adapting the segmented institutionalism perspective to analyze computing in the family shifts the focus to:

1. Achieving shared meaning, rather than efficient function
2. Conflicting and overlapping goals, rather than consensus

3. Including all stakeholders, rather than only direct users
4. Highlighting trade-offs, rather than evidence of success

I propose that leveraging this perspective for designing family technologies may offer new areas of investigation, identify open problems in existing work, and provide a powerful guide for analysis.

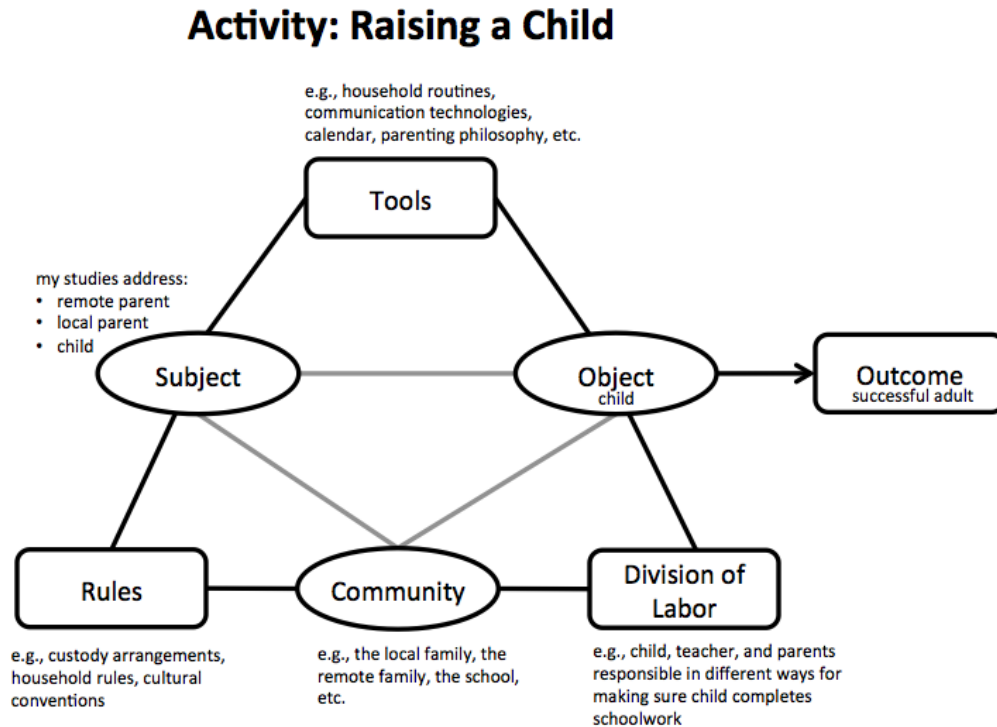
Segmented institutionalism emphasizes the importance of understanding the experience of the stakeholders involved with a technological intervention. One challenge is that participants may be hesitant to reveal conflicting motivations and disagreements when interviewed as a family unit. Hirschheim & Klein pointed out that loyalty to the group, the need to maintain authority, and the need to protect oneself pose serious challenges to the investigator in attempting to understand conflicting viewpoints [79]. Some strategies may help assuage these issues, such as interviewing each member in private and dividing families across workshops and focus groups (e.g., all children in one group, all grand-parents in another) during investigations. In my work, I strive to interview participants (including children) separately whenever possible. It is not surprising that this allowed me to get a differing perspectives from divorced parents, but it is interesting how important this methodological choice turned out to be in understanding the views of children. Through this process, I found that children and parents often have different views of perceiving and managing separation [187]. Additionally, children in divorced families may be particularly protective of their privacy because it is critical to some of the mechanisms they use to reduce tension between households [188]. These insights would likely have been impossible had I chosen to interview the family as a unit.

The design of a technological artifact in this perspective focuses not only on providing evidence of its success, but rather on highlighting tensions in how each stakeholder experiences the intervention. This provides opportunities to observe unintended consequences for users and non-users. In embodying uncovered tensions in technologies, satisfying all parties or achieving consensus is not necessarily possible or desired. Once trade-offs are identified, the designer may choose to align with a particular stakeholder or work towards building a



shared understanding between stakeholders (without necessarily seeking a functional resolution). However, it is important that the designer explicitly discusses this decision and considers its political implications. The paradigm's focus on change presents a challenge for evaluation, suggesting the need for an extended deployment to provide ample opportunity for family members to adapt and negotiate the artifact. Such deployments have previously proven quite challenging to the community, as most prototypes may not be robust enough for the demanding environment of the home. In my work, I have chosen to test the ShareTable by deploying it in the field. Rather than simply providing evidence of the system's success, I found it much more meaningful to also highlight the aspects of the system that proved problematic to the families or that detracted from its successful adoption. Frequently, those insights that are the most informative towards future directions for synchronous communication technologies for divorced families. In order to standardize some aspects of the process of drawing meaningful comparisons between systems that would allow for a true costs and benefits analysis, I created a questionnaire instrument to aid evaluators of communication systems.

Identifying with the segmented institutionalism perspective moves some questions to the forefront, while others diminish in importance. I have pointed to the context of divorce as one overlooked matter and have chosen to undertake this context as one of primary importance to my thesis. However, it is not the only context in which a new lens on designing for families may be most appropriate. In my investigations, considering the divergent goals and perceptions of intact families who are separated by work led to new insights [187]. Designs for intergenerational interaction may also benefit from the segmented institutionalist lens, as achieving shared meaning is an important goal of this context and the researcher must consider the divergent views of all stakeholders. Similarly, relationships that are often characterized by conflict or a lack of shared meaning, such as young siblings or relatives by marriage, may benefit from a segmented institutionalist approach. Another largely overlooked topic is addressing the needs of teenagers, whose role in the family is often defined by radical change and conflict. Previous work has shown that considering artifacts from a teenager's point of view can lead to a rich understanding of family technologies [71], but



**Figure 33:** The activity of raising a child articulated in terms of Activity Theory components.

few designs have explicitly considered supporting shared meaning and addressing conflicting goals between teenagers and families. Kling concluded that the segmented institutionalism perspective gains value as computing expands to more diverse groups [103]; it is my hope that this is also true in applying this view to design for families.

## 9.2 Activity Theory as a Lens for Understanding Remote Parenting

Activity Theory has been proposed a theory that may benefit HCI and CSCW (e.g., [74, 104]). This theory may provide a useful lens understanding communication technologies for parents and children because it privileges human beings as active and purposeful actors and acknowledges the co-constructive relationship between users and systems. Kuutti identifies three key principles of Activity Theory [104]:

1. Activity as basic units of analysis
2. Continuous change and development of activity systems

### 3. Artifacts (tools, rules, structures, etc.) and mediation of activity

An activity is a form of doing directed to transforming an object into an outcome. The HCI community has two major way of understanding the term “object” in the context of Activity Theory. For example, Nardi usually understands the term to mean “objective” or “goal to be accomplished” [126]. However, others prefer to consider the object to be the target of transformation, where the goal of the activity is to transform the object to the desired outcome [74, 104]. I take the second approach in this discussion, because it highlights that the object must be “sharable” for manipulation by the participants of an activity, but does not have to be tangible. In the context of raising a child, the child is in fact the object of the transformation (see Figure 33). The child, the remote parent, and the local parents are all subjects of interest as those *doing* the transforming. The subject’s interaction with the object is mediated by tools, such as a specific parenting philosophy, household routines, and communication technologies. The activity is further contextualized through the presence of a community (those who share the same object). For example, from the point of view of the child, the remote parent, the local parent, siblings, extended family, teachers, church leaders, etc. are all member of the “parenting” community. The involvement of each of these members in transforming the child is mediated by a division of labor. Each subject’s membership in the community is mediated by rules such as social conventions and (in the case of divorced families) custody agreements. In fact, all six components of Activity Theory interrelate and influence one another, though other connections are frequently omitted from the diagram.

When understanding how work-separated families manage separation, it may be most salient to focus on the factors related to the “Division of Labor.” From the work presented in Chapter 5, it seems that parents and children have a different understanding of what separation means for the division of labor in context of raising a child. For example, the child chooses to rely on the local parent, while the remote parent frequently seeks to maintain a more active role even remotely. When presenting the strategies families use to maintain contact, I relate “relying on a collocated parent for help” as one specific approach. This theme may seem strange because it is not focused on a mediating technology. However,

in the context of Activity Theory's definition of a mediating "tool," the help provided by the local parent can in fact be considered in this category from the point of view of the remote parent and the point of view of the child. Indeed, mediation by the local parent and a willingness to redistribute division of labor to assume more parenting responsibilities appeared to be a critical components to successful parent-child contact in work-separated families.

In considering the activity of raising a child from the perspective of different subjects in a divorced family, each component of the diagram can be more clearly articulated:

**Child as the Subject.** From the point of view of the child, the activity of "raising self" or growing up is mediated by tools such as own model of the world and community such as family, school, church, etc. In an intact family, both parents may have the opportunity to agree on the rule regarding the child's participation in these communities; however, in divorced families these rules frequently differ or even conflict. Some children have trouble transitioning between rules in different parts of the community, others use the conflicts to their immediate advantage to circumvent rules that may be inconvenient at the moment. Divorce severely disrupts the typical division of labor in a family, as each parent must perform all functions while having physical custody and frequently has any opportunity to perform any functions while remote. As fewer adults are potentially available to provide care and play, children may have to assume some of those responsibilities directly or find others who may be able to assist.

**Residential Parent as the Subject.** From the point of view of the residential parent, division of labor may be the aspect of raising the child that is most disrupted by divorce. Many of the residential parents in my studies found themselves in a position of providing a disproportionate amount of care support for the child. The residential parents also may find themselves in an uncomfortable position of balancing the rules imposed by the outside community (such as the custody arrangements agreed upon with the judge) and the specific in-the-moment arrangements that must be made in the process of child-rearing. For example, the judge may specify that the remote

parent is entitled to spend one hour per week talking with the child on the phone. In practice, the work of executing this arrangement falls to the residential parent, who may have trouble fitting this practice in with other rules of the house (e.g., no phone calls at dinner, homework before anything else, etc.) and the desires of others in the community (e.g., child may not want to disengage from playing with a friend to talk to the non-residential parent).

**Non-Residential Parent as the Subject.** From the point of view of the non-residential parent, rules become the most salient component of the activity of raising the child. The non-residential parent's interaction with the tools that mediate interaction with the child, with the community that interacts with the child, and with the division of labor around interaction with the child are all explicitly restricted with formal or informal rules. A custody agreement frequently defines specific arrangements of visitation, contact between parents, and even use of communication technologies. Additionally, the residential parent frequently has an opportunity to also put in place implicit rules for interaction and cut off portions of contact when these rules are not followed. For example, if the residential parent decides that mobile videochat in the home is too intrusive, he or she may decide to stop encouraging the child to charge the mobile device or even explicitly discourage the child from this type of interaction. Additionally, the non-residential parent may have his or her own rules about participation in the community, such as not wanting to interrupt the other household's routines or intrude on the other's privacy. Finally, other communities involved in raising the child may have rules about the non-residential parent's participation. For example, schools may only send certain information to the residential parent and doctors may by default only share medical records with the primary custodial parent. Thus, the non-residential parent's participation in the child's life may at times be tightly constrained by a complex network of explicit and implicit rules from a number of sources.

Of note from all three of the above descriptions, a focus on the “rules” portion of the diagram may be most relevant when discussing divorced families. Particularly for the non-residential parent, very explicit rules mediate not only membership in and relationship to the community, but also the division of labor and the use of tools that mediate the subjects ability to act in a transformational manner upon the child. The sheer number of different rules and the variety of sources for these rules severely complicate the activity of raising the child. These connections (which are not explicitly shown on the Activity Theory diagram) are in fact the most salient in influencing the adoption of communication systems. In the ShareTable deployment with first family, the system threatened to change the division of labor, particularly the parallel parenting paradigm of “dad’s house, dad’s rules; mom’s house, mom’s rules.” To prevent this change, the local parent put in place rules that severely limited the use of the system and felt that the benefit the ShareTable provided was not commensurate with its disruptive effects. In the second family, there were few initial conventions about use, but the use of this tool by the father interfered with parenting tools set in place by the mother (particularly, household routines). In the long run, agreed-upon rules would have to emerge about acceptable use of the system. Without rules mediating the use of the tool, it would eventually be rejected by the household that finds it to be disruptive. With higher-conflict families, it is likely that all rules relating to division of labor, relationship to the community, and use of tools would have to be moderated by a formal policy. Though encoding this policy explicitly into the tools themselves may be necessary to the communication system’s adoption, Activity Theory points to a possible danger of this approach. Because an activity is a dynamic unit that faces change and development, explicitly encoded rules may not be able to change and evolve with the freedom required to represent the accurate wants and needs of the family arrangement. This is a fundamental problem of court-mediated custody agreements [182] and an important challenge that must be addressed before a system like the ShareTable can be viable for high-conflict families.

Activity Theory acknowledges conflict and contradiction in activity systems, as individuals are participating in multiple activities simultaneously and “participation in connected activities have very different objects can cause tensions and distortions” [104]. This is

particularly salient to remote parent–child contact, as parents and children often have conflicting goals and motivations relating to maintaining conflict. In divorced families, the goal of “minimizing tension” between households frequently conflicts with the desire to communicate to participate in the activity of “raising the child.” There is actually a surprisingly similar dichotomy in work-separated parenting where the goal of maintaining contact may conflict with the desire to “minimize disruption to the household.” Understanding these tensions makes it clear that communication in separated families does not occur in a vacuum but is rather a part of a complex context where the choice to pick up the phone or launch Skype may have both positive and negative consequences.

### ***9.3 Future Directions in Supporting Remote Parent–Child Contact***

The work presented in this thesis addresses only a small portion of the problem and design space. There are numerous other contexts and solutions to explore.

#### **9.3.1 Better Understanding of Parent–Child Separation**

The two formative interview studies presented in this thesis contribute to the understanding of parent–child separation but do not provide conclusive evidence about the approaches and strategies used by families due to the small sample size of the studies and the word-of-mouth recruiting techniques. In order to understand how these findings generalize to the larger communities of separated families, it would be most helpful to distill the most important findings into a survey that would allow us to understand whether and how these findings might apply to the larger community. For example, in the case of divorced families, one may select a random sample of divorced families and ask the members of these families to respond to a simple survey asking about each of the challenges identified in Chapter 4. In the case of work-separated families, one may ask about each of the five strategies identified in Chapter 5 to better understand how these generalize to the larger population.

Additionally, my work only draws the contrasts between parent–child separation due to work and due to divorce. Highlighting the unique aspects of each situation makes it apparent that context of separation plays a critical role in understanding and designing

technologies for remote parent–child contact. In fact there are many other types of parent–child separation, each characterized by unique challenges and constraints. Some examples may include hospitalization, incarceration, and immigration. In the majority of cases of separation (i.e., divorce, military, hospitalization, incarceration, and immigration), policy and infrastructure are frequently two of the biggest constraints on the design space. A successful future agenda for designing for remote parent–child contact would have to be supported by a strong collaboration with the appropriate policy experts, as well as those with the means to provide the necessary infrastructure to make new designs viable in complex contexts.

### **9.3.2 Testing the Lessons from the ShareTable with More Families**

An agenda that focuses on impact would have to balance the potential benefit of a novel technological approach with the likely penetration of the market audience. While the furniture-based communication idea forwarded by the ShareTable was successful, it is unlikely that most families would be willing or able to accept such a large single-use appliance into their homes. In making a novel communication idea available to a larger audience, it is necessary to leverage the infrastructure already available in the home. There is one successful example of this sort of a transition in HCI. The Family Story Play system was tested in the lab with a number of novel hardware components, for example the book knew when a page was turned in order to support the remote readers in staying on the same page [142]. Having a physical book object provided the benefit of a familiar interaction and clear physical metaphor. However, this approach was deemed to be too complex and too fragile to test in the home. As an alternative, the investigators pulled out two ideas that were deemed to key to the system and that did not require specialized hardware: (1) combining a shared storybook with videoconferencing and (2) having a puppet character guide the adult in making the reading more engaging to the child. Both of these ideas were included in a browser-only implementation of the system which could then be provided at no charge to thousands of families [145]. This approach seems particularly promising in bringing the benefits of a system such as the ShareTable to a larger number of families. There are three key ideas of the ShareTable system that could be incorporated in a standalone computer or





**Figure 34:** An artist sketch of a scenario of three ShareTables in use in a preschool classroom.

mobile device program: (1) easy-to-initiate paired videoconferencing, (2) a shared activity context (with digital, rather than physical artifacts), and (3) overlapping video for creating a metaphorical sense of touch. By incorporating these lessons into an easy-to-deploy application (e.g., an app for the iPad app store), metrics of use can be collected from a considerably larger population. If a large-enough base of users is established, the presence of each of the three aspects above can be systematically manipulated as a variable to allow the researcher to untangle the relative importance of each of the three characteristics on system adoption.

### 9.3.3 Expanding Use of ShareTable-Like Technologies to Other Domains

One of the main points of my thesis is that communication technologies can increase participation in children's lives from important others. This has potential impact in a number of domains, including those outside of the home. For example, the scenario below demonstrates how a ShareTable-like system can allow a teacher to become the facilitator of learning connections rather than the only source of educational content (also, see Figure 34):

In the afternoon, the children at the Sunshine Way Preschool have some unstructured time to play. Some kids have already set up toys on the carpet in the center of the room, while others have congregated at several ShareTables in the corner of the classroom. Rita is having a tea party with Mary, despite the fact that Mary is currently at a hospital in a neighboring city. Each girl can see the toys the other has set up projected on the surface of her table. Three boys are enthusiastically listening to the latest adventures of “Captain Underpants” as read by Mr. Dapper from the local retirement village. They can follow along as Mr. Dapper’s hand moves across the page and see all the pictures as the book is projected right on the table. Kelly and Alex from a specialized school for the Deaf in a town across the country are excitedly motioning for Nick to join them in a board game. Nick is a little unsure, because he doesn’t know sign language yet, but the game is all set up and looks awfully inviting...

ShareTable-like systems can be part of unstructured experiences as described in the use scenario, but also as part of more explicitly coordinated learning opportunities. Teachers can draw upon the resources provided by the ShareTable in the same way that they are already familiar with coordinating field trips, theme lessons, and other classroom experiences. Here are a few examples of possible activities:

- Activity where children learn about history by inviting members of a retirement community to show photos and talk about their childhood
- Virtual visit to a museum with members of the staff showing a different artifact or sets of artifacts at each station.
- Coordinating with a preschool in a different country as part of learning a foreign language
- Inviting a class of older students to teach a concept to the preschool class (two older students per group of four younger students)
- Weekly reading groups coordinated by members of a retirement community where each station is reading and talking about a different book

A key aspect of the ShareTable in the classroom is that an activity should have the potential to benefit all of the participants, whether it is by empowering the community’s elders to inspire the new generation, by meeting the educational goals of another learning institution, or by providing classroom access to those who otherwise would not have it.

This is only one example of the possible use of the ShareTable system outside of the home. This powerful approach to remote synchronous communication with children can be applied to a number of other domains, such as providing health services to remote participants, distance education, and increasing community engagement.

## CHAPTER X

### CONCLUSION

Divorce, work travel, military deployment, immigration, and many other reasons may separate a parent and a child. Children, remote parents, and local parents all struggle with separation in different ways when it occurs. Because of the physical nature of the parent–child relationship, with its roots in care and play activities, remote parenting can be extremely challenging. The goals of my thesis are to better understand the role of communication technology in parent–child separation and design a novel communication system that may be able to address some of the challenges faced by these families.

There are four main contributions of this thesis (see Appendix D for details). First, I conducted in-depth interviews with parents and children from separated families to get a better understanding of two contexts of separation. I found that both parents and children in divorced families balanced motivations to maintain contact with the motivation to reduce conflict between the two household. This tension frequently led to remote contact being rigidly scheduled, which didn’t work well for the way children seek to communicate. In work-separated families, I found that parents and children frequently had different approaches to dealing with separation, with parents focusing on remote communication and children focusing on colocated adults and activities. Both divorced and work-separated families frequently relied on the phone as the main means of communication despite the difficulties of engaging children in phone conversations. Videochat was rarely used routinely because of the difficulties in establishing the necessary infrastructure and setting up the connection. Remote conversation was usually scheduled by parents, rather than driven by children. In both separation contexts, parents expressed frustration with engaging the child in conversation remotely. Based on the findings of these interviews, I considered the emotional aspects of communication technologies that may contribute to or detract from a system’s adoption. I refined these ideas to create the Affective Benefits and Costs of

Communication Technologies (ABCCT) questionnaire and conducted an initial validation and reliability analysis of the resulting instrument—the second contribution of this thesis. My next contribution was to help meet the needs of separated families by designing a novel communication technology that would provide additional emotional benefits without incurring additional emotional costs over current communication technologies. An iterative design cycle led to the creation and initial proof-of-concept study of the ShareTable system—a communication system which combines easy-to-initiate videochat with a tabletop video space for shared activities. The fourth contribution was the field deployment of the ShareTable system. The deployment with four Atlanta-area divorced households showed the promise of the ShareTable in improving the quantity and quality of parent–child communication. Conversations over the ShareTable were frequently initiated by children (unlike with previous technologies) and included a number of activities that would be impossible with current communication systems. Particularly important, the families appropriated the shared tabletop space provided by the system to communicate metaphorical touch. Though the ShareTable did provide an additional source of conflict for these families as the parents tried to negotiate rules over appropriate use of the system, their feedback highlighted the promise of this approach to communication and suggested future directions for work in this space.

There are three key take-away points to draw from the work presented in this thesis: (1) the parent–child relationship is a unique communication context and the circumstances of the separation influence strategies used and challenges faced by parents and children; (2) emotional benefits and costs is one good way of considering and evaluating communication technologies in the home; and (3) communication technologies can increase and change the nature of remote contact with children, when designed with specific considerations for the context of separation. Future work in this space can focus on understanding new parent–child communication contexts, designing additional approaches for evaluating communication technologies, and considering new circumstances where remote contact with children may achieve broader impact.

## APPENDIX A

### AFFECTIVE BENEFITS AND COSTS OF COMMUNICATION TECHNOLOGIES (ABCCT) QUESTIONNAIRE

This Appendix contains the full text of both the adult and child final versions of the ABCCT, as well as directions for use.

#### ***A.1 Full Text of the ABCCT-Child (7 scales: 22 items)***

Directions: Substitute the name of the communication medium for ⟨M⟩ and the name of the communication partner for ⟨P⟩ at the appropriate places in the survey. Participants should respond to each statement with: “Never,” “Rarely,” “Sometimes,” “Usually,” “Always,” or “Doesn’t Make Sense Here.” For children under the age of 10, this survey is validated only for reading the questions out loud to each participant.

##### **A.1.1 Benefits (4 Scales: 13 items)**

###### *A.1.1.1 Emotional Expressiveness*

- Talking with ⟨P⟩ using ⟨M⟩ helps me tell how ⟨P⟩ is feeling that day.
- Talking with ⟨P⟩ using ⟨M⟩ helps me let ⟨P⟩ know how I am feeling.
- Talking with ⟨P⟩ using ⟨M⟩ helps me see how much ⟨P⟩ cares about me.

###### *A.1.1.2 Engagement & Playfulness*

- It is boring to use ⟨M⟩ with ⟨P⟩.
- I am excited about using ⟨M⟩ with ⟨P⟩.
- I have fun with ⟨P⟩ while using ⟨M⟩.

###### *A.1.1.3 Presence-In-Absence*

- Talking with ⟨P⟩ using ⟨M⟩ helps me feel closer to ⟨P⟩.
- After we are done talking, I still keep thinking back to something ⟨P⟩ shared using ⟨M⟩.

- Talking with ⟨P⟩ using ⟨M⟩ helps me feel more connected to ⟨P⟩.

#### *A.1.1.4 Opportunity for Social Support*

- ⟨P⟩ makes me feel special when we talk using ⟨M⟩.
- Talking with me using ⟨M⟩ helps ⟨P⟩ be there for me when I need them.
- Talking with ⟨P⟩ using ⟨M⟩ when I am having a bad day helps me feel better.
- Talking with ⟨P⟩ using ⟨M⟩ helps me feel less worried about something.

### **A.1.2 Costs (3 Scales: 9 items)**

#### *A.1.2.1 Feeling Obligated*

- I have to talk to ⟨P⟩ using ⟨M⟩ even if I don't want to.
- I feel guilty if I don't answer when ⟨P⟩ talks to me using ⟨M⟩.
- I have to answer when ⟨P⟩ tries to talk to me using ⟨M⟩ even if I don't want to.

#### *A.1.2.2 Unmet Expectations*

- I feel sad when ⟨P⟩ isn't around when I try to talk to ⟨P⟩ using ⟨M⟩.
- I feel sad when ⟨P⟩ takes too long to respond when I try to talk to ⟨P⟩ using ⟨M⟩.
- I feel sad when ⟨P⟩ doesn't pay enough attention to me when we use ⟨M⟩.

#### *A.1.2.3 Threat to Privacy*

- I worry that ⟨P⟩ might learn something using ⟨M⟩ that I want to keep secret.
- I worry about my privacy while ⟨P⟩ and I were using ⟨M⟩ together.
- I worry that others may overhear or see something that ⟨P⟩ and I share using ⟨M⟩.

### **A.2 Full Text of the ABCCT-Adult (7 scales: 26 items)**

Directions: Substitute the name of the communication medium for ⟨M⟩ and the name of the communication partner for ⟨P⟩ at the appropriate places in the survey. Participants should respond to each statement with: "Never," "Rarely," "Sometimes," "Usually," "Always," or "Not Applicable."

### **A.2.1 Benefits (4 Scales: 14 items)**

#### *A.2.1.1 Emotional Expressiveness*

- Communicating with ⟨P⟩ using ⟨M⟩ helps me tell how ⟨P⟩ is feeling that day.
- Communicating with ⟨P⟩ using ⟨M⟩ helps me let ⟨P⟩ know how I am feeling.
- Communicating with ⟨P⟩ using ⟨M⟩ helps me see how much ⟨P⟩ cares about me.

#### *A.2.1.2 Engagement & Playfulness*

- I feel that contact with me using ⟨M⟩ is engaging for ⟨P⟩.
- I am excited about using ⟨M⟩ with ⟨P⟩.
- I have fun with ⟨P⟩ while using ⟨M⟩.

#### *A.2.1.3 Presence-In-Absence*

- Communicating with ⟨P⟩ using ⟨M⟩ helps me feel closer to ⟨P⟩.
- After we are done communicating, I still keep thinking back to something ⟨P⟩ shared using ⟨M⟩.
- Communicating with ⟨P⟩ using ⟨M⟩ helps me feel more connected to ⟨P⟩.

#### *A.2.1.4 Opportunity for Social Support*

- Communicating with ⟨P⟩ using ⟨M⟩ helps me provide ⟨P⟩ with social support.
- ⟨P⟩ makes me feel special in our contact using ⟨M⟩.
- Communicating with me using ⟨M⟩ helps ⟨P⟩ be there for me when I need them.
- Communicating with ⟨P⟩ using ⟨M⟩ when I am having a bad day helps me feel better.
- Communicating with ⟨P⟩ using ⟨M⟩ helps me feel less worried about something.

### **A.2.2 Costs (3 Scales: 12 items)**

#### *A.2.2.1 Feeling Obligated*

- I worry that ⟨P⟩ feels obligated to contact me using ⟨M⟩.
- I have to talk to ⟨P⟩ using ⟨M⟩ even if I don't want to.
- I feel guilty if I don't answer a contact ⟨P⟩ makes using ⟨M⟩.
- I have to answer when ⟨P⟩ tries to contact me using ⟨M⟩ even if I don't want to.



#### *A.2.2.2 Unmet Expectations*

- I feel sad when  $\langle P \rangle$  isn't around when I try to contact  $\langle P \rangle$  using  $\langle M \rangle$ .
- I feel sad when  $\langle P \rangle$  takes too long to respond when I try to contact  $\langle P \rangle$  using  $\langle M \rangle$ .
- I worry that I am not meeting  $\langle P \rangle$ 's expectations for our contact using  $\langle M \rangle$ .
- I feel sad when  $\langle P \rangle$  doesn't pay enough attention to me when we use  $\langle M \rangle$ .

#### *A.2.2.3 Threat to Privacy*

- I worry that  $\langle P \rangle$  might learn something using  $\langle M \rangle$  that I want to keep secret.
- I worry about my privacy while  $\langle P \rangle$  and I were using  $\langle M \rangle$  together.
- I worry that others may overhear or see something that  $\langle P \rangle$  and I share using  $\langle M \rangle$ .
- I worry that I am violating  $\langle P \rangle$ 's privacy during our contact using  $\langle M \rangle$ .

## SELECTED SKETCH EXPLORATIONS OF THE DESIGN SPACE

Figure 1 illustrates the system architecture across four components:

- (a) Front view of the system:** Shows a wooden table with a frame. A camera is mounted on top, with speakers on either side. A power connection is indicated at the bottom.
- (b) Video-Conference System:** Features a computer monitor displaying a video conference, a haptic remote control, and a video-conference system unit.
- (c) Dry-Erase Board:** A wooden table with a dry-erase board on top. A camera is mounted on the table, connected to a video-conference system. A rear projector is also shown.
- (d) Locked Boxes:** A collection of colorful boxes. A Bluetooth lock is shown, along with a wearable tag and a charger.

Send-A-Rainbow

Send-A-Voice Message

Pedometer

Send-a-Squeeze

Send-A-Picture Message

Send-An-Emoticon

Light-Tracker

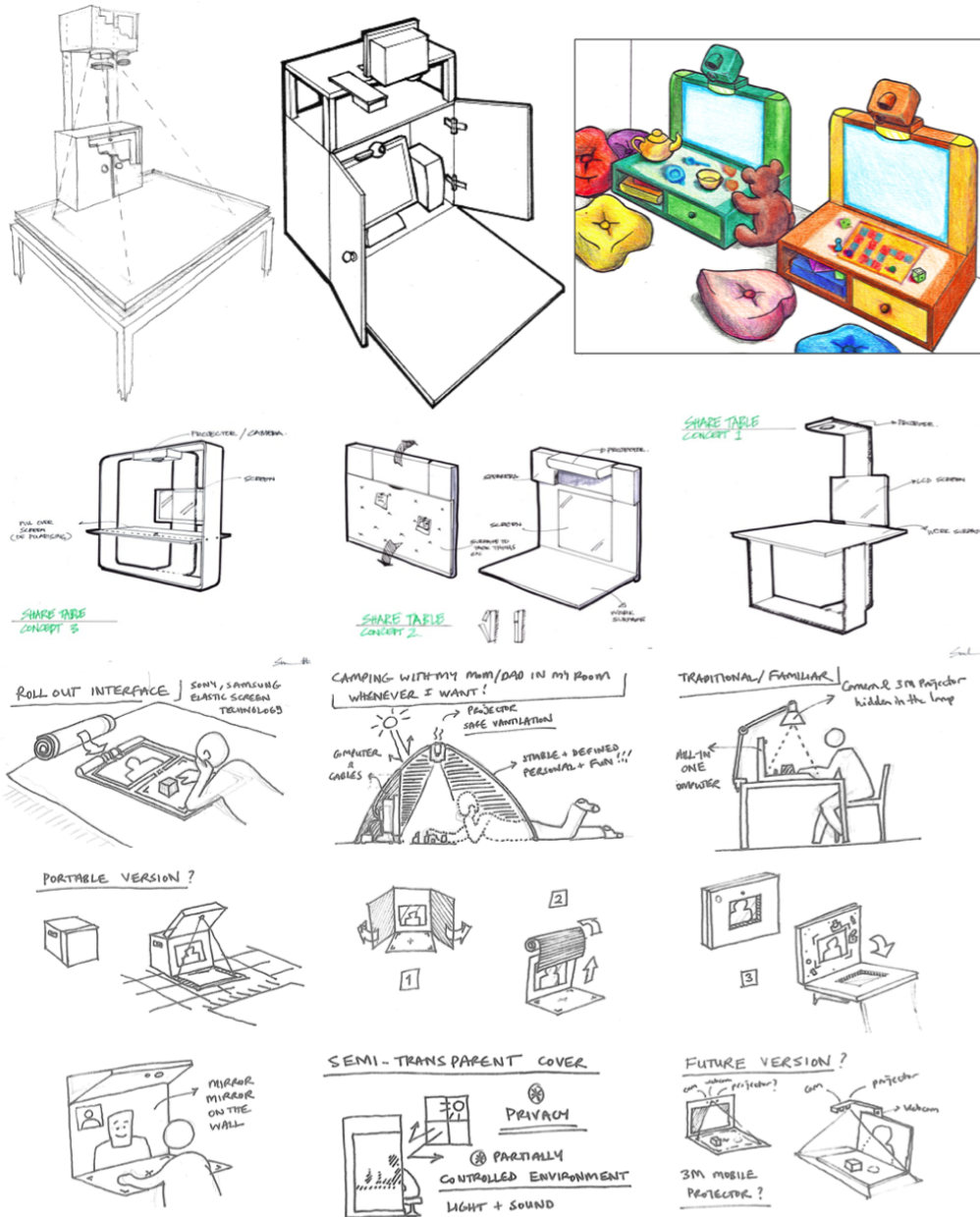
GPS

Audio-Tracker

Send-A-Voice Message

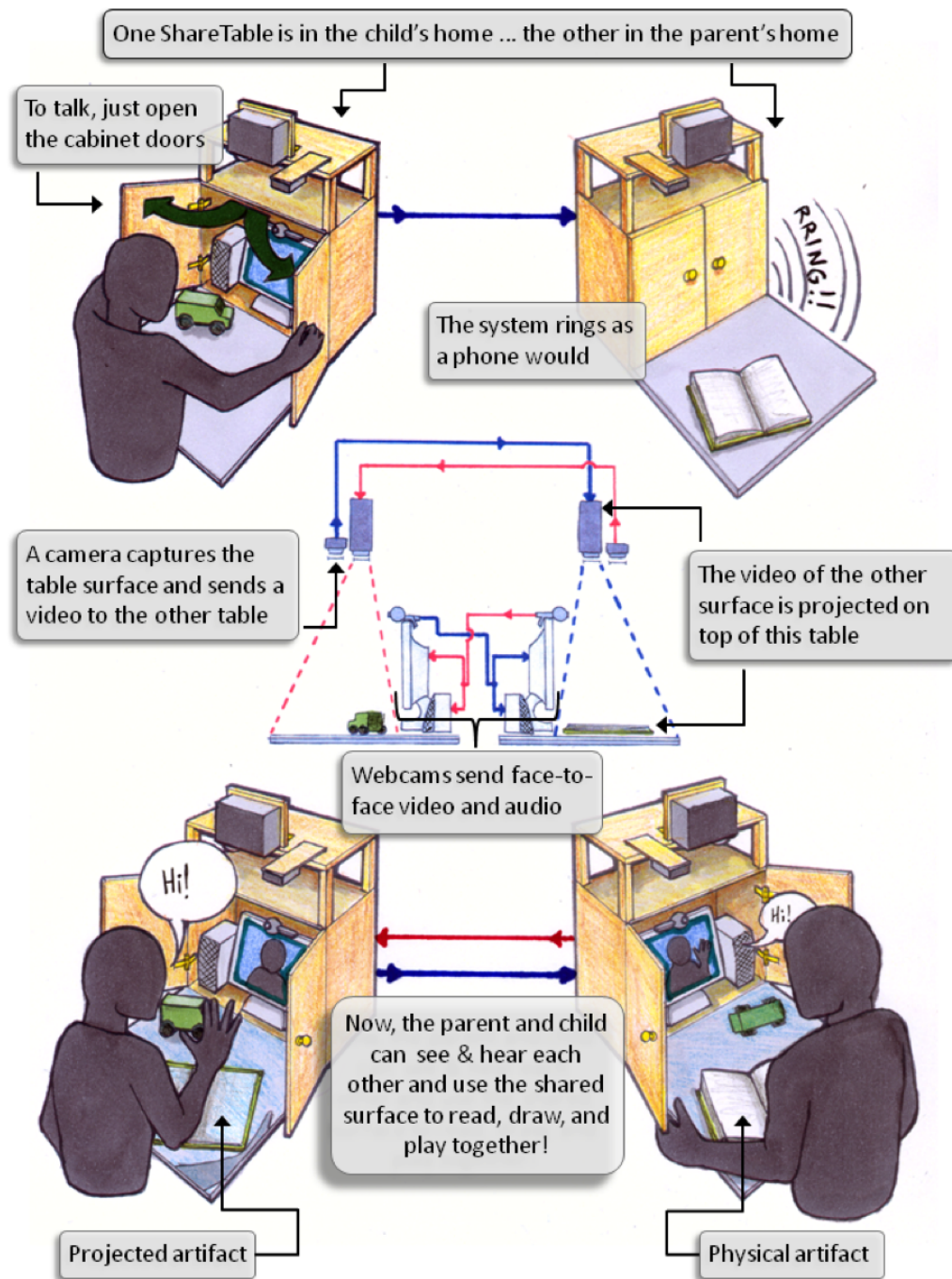
Send-a-Squeeze

## ShareTable Conceptualization Sketches



## APPENDIX C

### SHARETABLE SYSTEM USE DIAGRAM



## APPENDIX D

### SUMMARY CHART OF THESIS CONTRIBUTIONS

The following chart provides an overview of the contributions of this thesis, the investigations involved, and the specific methods, participants, and data gathered. The color-coding specifies aspects of the work where the same pool of participants was used for multiple investigations. For example, interviews with 14 parents were used to both provide a better understanding of parent–child separation due to work and to help validate the ABCCT questionnaire by comparing interview and questionnaire responses.

Contribution	Investigation	Methods	Participants	Relevant Data Used
Better understanding of parent-child separation, in two contexts.	Interviews with work-separated families	In-depth semi-structured interviews	14 travelling parents 14 children (age 7 – 13)	Transcripts of interviews
	Interviews with divorced families	In-depth semi-structured interviews	Parents and children from 10 divorced families	Transcripts of interviews
		Drawing exercises	5 children (age 7 – 14) from above families	Drawings of “magical” artifacts
Design and validation of the ABCCT Questionnaire	Internal consistency	Administered ABCCT to children in small group setting in a school and adults online	45 children (age 8 – 10) 110 adults	Questionnaire responses analyzed for Cronbach's Alpha
	Test-Retest reliability	Administered ABCCT to a group of participants with two weeks between measures	13 adults (filled out 27 ABCCTs, twice) 5 children (filled out 10 ABCCTs, twice)	Correlation between the first and second set of ABCCT's taken by each participant
	Convergent validity with SCQ	Administered ABCCTs and SCQ to adults	14 adults	Correlation between the benefits dimension of the ABCCT and the SCQ
	Convergent validity with interviews	In-depth semi-structured interviews and administered ABCCT to adults and children	14 travelling parents 14 children (age 7 – 13)	Convergence between interview codes and ABCCT responses calculated using Cohen's Kappa
	Discriminating between technologies	Administered ABCCT to adults online	110 adults	Comparison between most reported media using the Mann-Whitney test
Design, implementation, and proof-of-concept of the ShareTable system	Iterative design of the ShareTable	Iterative cycles of sketching and feedback	Informal feedback on sketches from 11 parents in an online forum and ongoing correspondence with 2 parents	Informal feedback from participants on presented sketches of ideas
	Lab study of a functional ShareTable prototype	Lab study comparing videochat and ShareTable through specific tasks for participants; free-time for participants to explore the system	7 parents 7 children (age 7 – 10)	Researchers' notes about system use, time-to-completion measures, interviews and questionnaires post-use
Field evaluation of the ShareTable system, showing adoption in the wild	ShareTable deployment in 4 homes	Collected pre- and post-deployment ABCCT, NRI, and communication diaries. Conducted weekly semi-structured interviews with participating families.	2 divorced parents and 1 child (age 7) 2 divorced parents and 2 children (age 7 and 11)	Interview and video log transcripts and field notes Questionnaire responses (descriptive stats) Lengths and frequencies of communications from diaries (descriptive stats)



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## VITA

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